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NATIONAL FIRE PROTECTION ASSOCIATION

Quarterly

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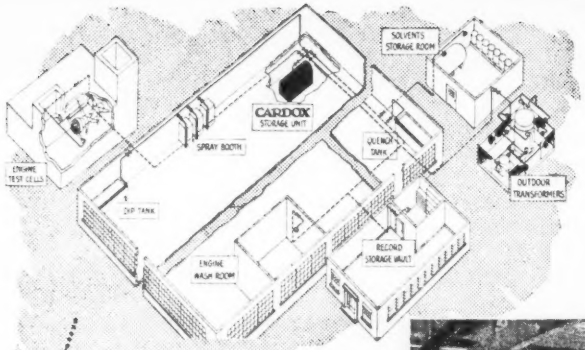

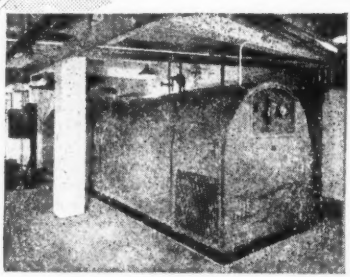

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of the

NATIONAL FIRE PROTECTION ASSOCIATION

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Acme.

The largest fireboats and the most powerful fire department in the world were unable to prevent total destruction of this New York pier on Sept. 29, with a loss of $3,500,000. After a long series of disastrous fires in New York harbor piers, New York has still not learned the obvious lesson that fire in wooden piling or timbers under a pier deck, having no fire walls, no automatic sprinklers and no means of access, cannot be controlled by conventional methods of manual fire fighting.

The Quarterly

Vol. 41 October, 1947 No. 2

Fire Tragedies and Their Lessons.

By Robert S. Moulton.

Fire takes an annual toll of life in the United States estimated at 10,000 or more. So much has been said and written about the problem of loss of life by fire that the public should surely be conscious of the ever present fire danger, but year after year the toll continues. The only statistical indication of progress is that the annual loss of life estimates have not increased in proportion to the increase in population. We may perhaps take some small comfort in this, but the situation is still appalling.

Most of the lives are lost in fires which individually claim only one or two victims and receive little public notice. It is only the major fire tragedies, in which large numbers of people are killed, which receive general publicity and exert some influence for fire safety. A hundred lives lost in a hundred individual fires go almost unnoticed except by those immediately concerned; a hundred lives lost in a single fire make front page news and may result in action to correct in other buildings the particular hazardous conditions responsible for the tragedy. But the lessons have at best been only very imperfectly learned, and some of the most important have gone largely unheeded. All too often the measures which have been taken have been ineffective, due to a lack of knowledge of the fundamentals of fire protection.

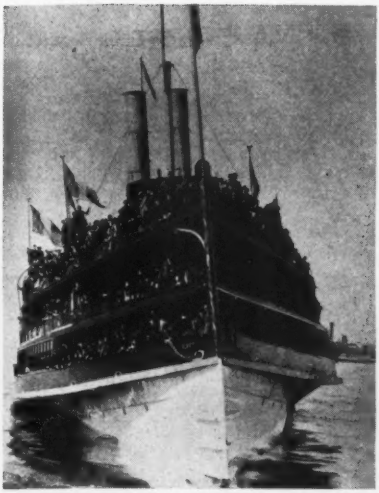
Pictured here are fires representing a small selection of the many fire tragedies of recent history. These fires are only a typical sample. They occur in every sort of property and under every conceivable set of conditions. Practically all are due to well-known causes, and practically all of the loss of life could be prevented by exercise of well-known precautions for life safety from fire.

It is easy to blame a fatal fire on a carelessly discarded cigarette, on the improper installation of heating appliances, on lack of maintenance of electrical equipment, and similar common causes. After a fire, one can readily point to the factors that have been responsible for its spread — the open stairways, the lack of fire walls, the lack of automatic sprinklers, inadequate alarm facilities, delay in calling the fire department, and the various other factors

(Turn to page 87)

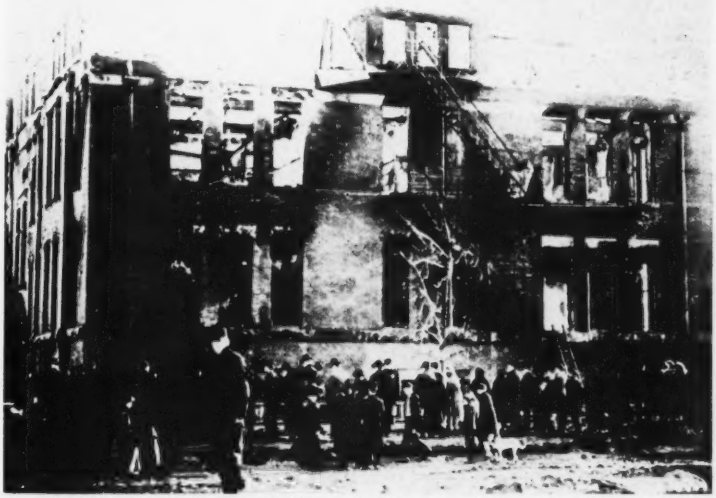
This article was presented as an illustrated address at the Fifty-first Annual Meeting of the N.F.P.A., Chicago, May 26-29, 1947.

A contemporary print of the Peshtigo, Wis., forest fire in which 1,152 lives were lost. Few people know about this fire, which occurred simultaneously with the great Chicago Fire of October 9, 1871. This is another reason for the observance of Fire Prevention Week during the second week in October.



The *General Slocum*, the excursion boat that burned in the East River in New York on June 14, 1904, where more than 1,000 died. It was only after many other ship disasters in later years that the problems of marine fire safety were seriously attacked.

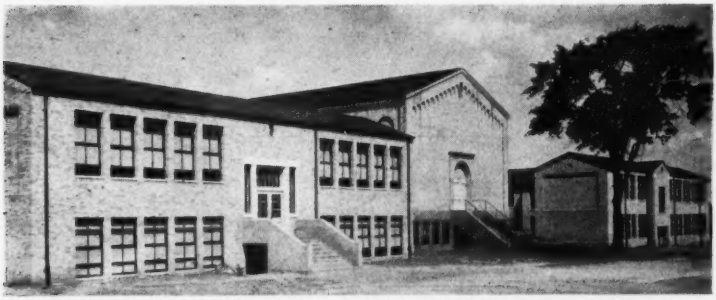
The Triangle Shirt Waist Company fire in New York on March 25, 1911, was responsible for 145 deaths. Light combustible material in a clothing factory created a flash fire and panic. Doors opened the wrong way, inward instead of outward.



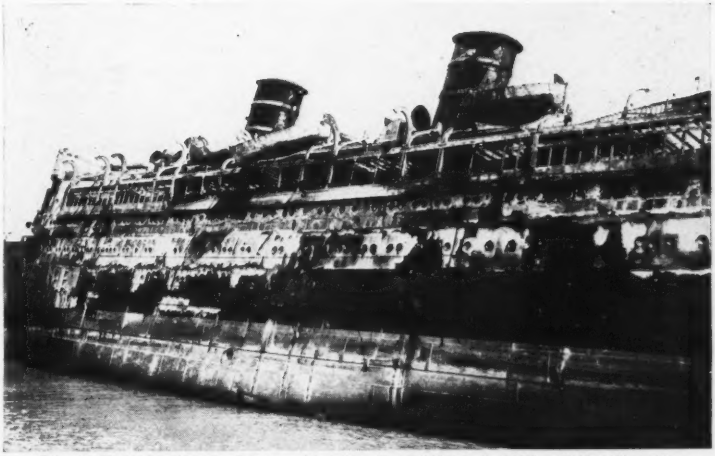
The Lakeview School in Collinwood, Ohio, fire of March 8, 1909, where 175 died. This fire contributed much toward improvement in school design and resulted in increased school fire safety. The lessons, however, were only partly learned, and we still have been burning many schools.

A rural school in Cleveland, South Carolina, where 77 died on May 17, 1923. This picture shows only the ruins. No photograph is available of the school before the fire. Here is a case where the lessons of the previous school fires were not learned. A holiday celebration was held on the second floor with only a single exit.

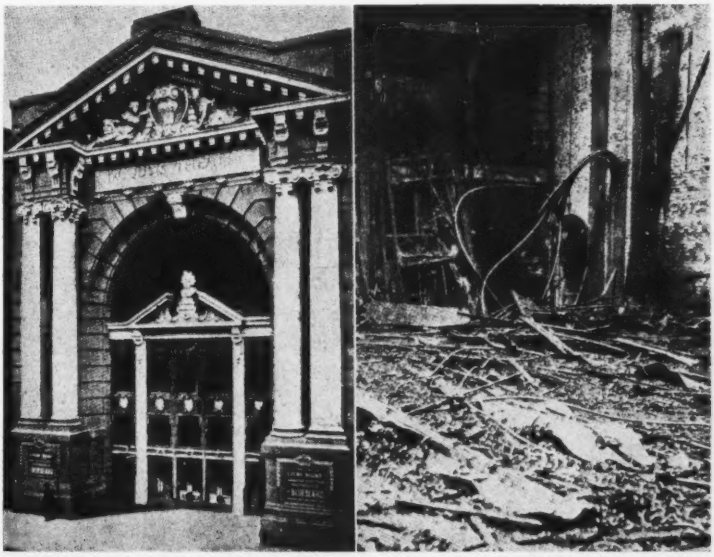
The Babbs Switch, Okla., school, where 36 lives were lost in a fire that started in a Christmas tree, Dec. 24, 1924. One exit; barred windows.



Parents sent their children to the Consolidated School in New London, Texas, with every confidence that they were going to a thoroughly fire-safe school. However, while the structure looks substantial, proper care had not been taken in the gas installation, and natural gas exploded, killing 294 children and teachers on March 18, 1937.

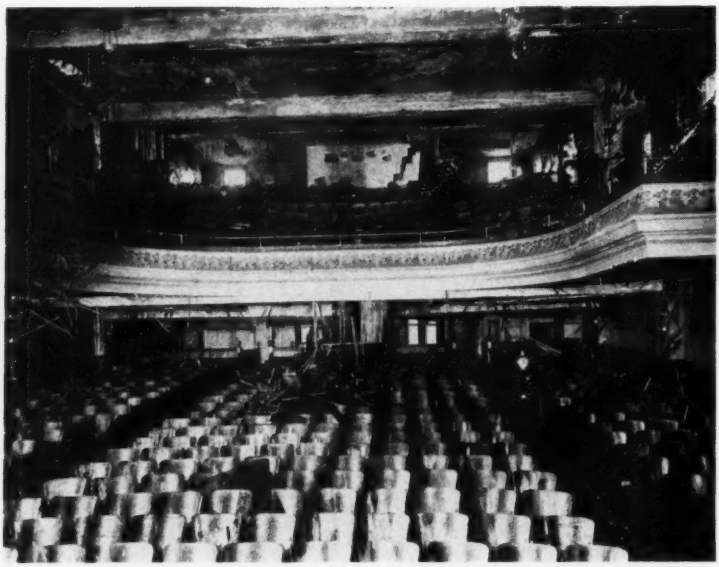


The hull of the *Morro Castle* after the fire of Sept. 8, 1934, off the New Jersey coast, where 125 lives were lost. It was only after the fire that concerted measures were taken for safety of life from fire at sea.



The Iroquois Theatre fire in Chicago on December 30, 1903, was responsible for 600 deaths. At the left is the entrance of the building; on the right, a section of the ruins of the interior. This fire has been responsible for measures instituted in Chicago and other parts of the country that have contributed greatly toward improved safety in theatres. This is one fire where the lessons have been fairly well learned. We cannot say as much for many others.

The Ohio State Penitentiary in Columbus, Ohio, was an impressive looking building. One would not have thought that a fire could occur here and kill 320 people, but on April 23, 1930, fire occurred in a cell block area, with prisoners locked behind bars trapped and cremated.



The interior of the Laurier Palace Theatre in Montreal after the fire of Jan. 9, 1927. Here was a case where the lessons of the Iroquois Theatre fire were not applied. The exits were narrow and totally inadequate.

The dance hall in Natchez, Miss., where 207 were killed on April 23, 1940. This fire should have served as a warning as to the danger of the combination of flammable decorations and inadequate exits in a place of public assembly. However, this fire received little publicity. It was a negro night club; those killed were negroes, and in the southern newspapers, this did not receive the publicity that might otherwise have been expected; so the country, as a whole, heard relatively little about it.

The Cleveland Clinic fire of May 15, 1929. The N.F.P.A., long before the fire, had issued recommended standards for the safe storage of nitrocellulose film, but it took this fire, which cost 122 lives, to make the public realize the hazard of this type of film and to secure its virtual elimination from X-ray use in hospitals.

The front of the Study Club, Detroit, after the fire of Sept. 20, 1929, which took 22 lives of night-club patrons in the "fireproof" rear section of the building, which had grossly inadequate exits. This fire, which originated in highly combustible decorations, should have served as a warning as to the hazards of places of public assembly of this character, but because only 22 were dead, the obvious lessons of the fire were not heeded elsewhere.

The ruins of a home for the aged in Garfield Heights, near Cleveland, Ohio, where 13 people died on Feb. 2, 1946. Many people have had the idea that in one-story buildings they are safe from fire, but where the construction is highly combustible — in this case, plywood lacking proper fire stops in the attic spaces — fire can flash so rapidly that even in one-story buildings with several exits, loss of life can occur.

A gas explosion and fire in Cleveland, Oct. 20, 1944, took 130 lives. City planning and zoning should segregate potentially hazardous industrial operations from residential areas, but economic factors in our older cities have made such segregation seem impracticable, except in the case of a few recognized highly explosive materials.

The Ringling Brothers and Barnum & Bailey Circus fire, Hartford, July 6, 1944, took 168 lives. This fire, the first of its kind, clearly focused public attention upon the hazard, and immediate steps were taken to correct similar hazards elsewhere.

The Lacoste baby home, Auburn, Maine, after the fire on Jan. 31, 1945, in which 16 babies were killed. Repeated fire experience shows that the American public still does not realize that a building which is suitable as a private dwelling may be wholly unsafe for institutional occupancy.

Dwelling in Summit, Ill., Dec. 18, 1945, 4 children dead. The total loss of life by fire in one- and two-family dwellings is much greater than in all the others combined, although, since only small numbers of lives are lost in each, they do not receive much public attention.

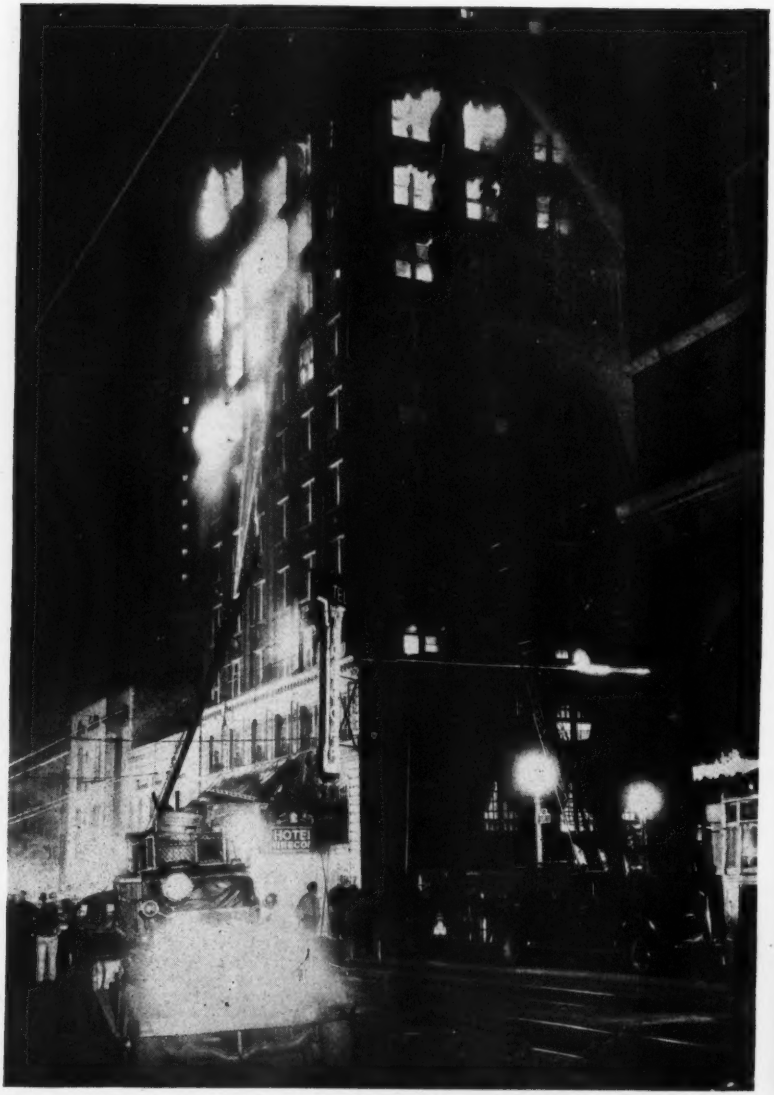
The Ringling Brothers and Barnum & Bailey Circus fire, July 6, 1944, focused public attention upon the hazard, and immediate steps were taken to correct similar hazards elsewhere.

A Detroit factory fire, Aug. 13, 1945, 15 dead. The highly combustible occupancy on the first floor and lack of proper exits had been criticized by the fire department, but no effective action had been taken by the owners to correct its hazards. Fire flashed up the open stairway during the noon hour, and a number of women on the second story did not detect the fire at once because they were listening to a juke box.

The Cocoanut Grove night club fire, Boston, on Nov. 28, 1942, was responsible for 492 deaths. This fire received such extensive publicity that the lesson of the danger of combustible decorations and inadequate exits was well registered. However, little public attention was given to the fact that this was a "fireproof" building, and the lesson that a "fireproof" building is not necessarily safe for its occupants went unheeded.

A burning church in Baltimore, Dec. 6, 1944. The people in the church hall had been complaining about the heat for some time before discovery of a fire which had been burning undetected in a blind attic. Then, panic seized those present, and though the exits were reasonably adequate, eight lives were lost. After innumerable fires, the danger of panic is still not generally appreciated.

The LaSalle Hotel fire, Chicago, June 5, 1946, 61 dead. Combustible interior finish, delayed alarms, open stairways. (Complete report in Quarterly, July, 1946.)



The Winecoff Hotel in Atlanta, Dec. 7, 1946, 119 dead. Another "fireproof" building with a single open stairway as the only exit. The lessons of previously fatal hotel fires still remain to be put into practice. (Complete report in Quarterly, Jan., 1947.)

The Canfield Hotel in Dubuque, Iowa, where 19 were killed on June 19, 1946. (Complete report in Quarterly, July, 1946.)

Saskatoon, Canada, Dec. 7, 1946, 11 lives lost in still another "fireproof" hotel. A gasoline stove was responsible for fire which flashed up the open stairway. The hotel fire alarm system, which a new owner had assumed was connected, turned out to be inoperative, and there was a long delay in calling the fire department.

The open stairway of the Niles Street Convalescent Home, Hartford, where a Christmas fire, due to a homemade electric Christmas tree lighting outfit, flashed up the open stairway, and 15 elderly ladies were killed.

A Boston business building, after a fire March 21, 1947. This was a typical brick-joisted business building, stores on the first floor, miscellaneous tenants above. On one of the upper floors, there was a small factory operated by a man who employed a number of women, one of whom was his wife. When the fire occurred, he rushed out of the building. Several women were left in the room. They were only four feet from a safe exit across a narrow corridor. There was little or nothing to burn in the corridor, but the heat, smoke and fire gases came up an open stairway, filled the space, and the women were trapped. After the fire, the man, so the story goes, asked a fire department officer, "Where is my $300?" Only after he had been given his money, which firemen had found in the building, did he say, "Where is my wife?" His wife was not killed, but four other women were, and a man who had re-entered the burning building to save his valuables.

The wreckage of an airplane after a crash fire in Newfoundland on Sept. 18, 1948, when 18 escaped, but 17 lost their lives as fire trapped them. Fire is the greatest single cause of airplane fatalities.

A modest dwelling in Rock Falls, Ill., where five of six children, sleeping in one room, were killed in a fire on Dec. 13, 1946. What happened will probably never be known, but the picture tells its own story. Note oil drum on chair; if there was similar carelessness in the installation of an oil-burning heater, the fire is not difficult to explain.

which repeat themselves time after time in fire reports. Most fatal fires could be simply explained as due to carelessness or ignorance. Such explanations are obviously valid as far as they go, but we should probe deeper in trying to ascertain the underlying reasons for loss of life by fire. I am convinced that the fundamental reason is that, though we may be loath to say it, the action of the American public shows all too clearly that to them the Almighty Dollar is far more important than human life. The average individual has to deal with the problem of the dollar every day, every hour, but is in personal jeopardy from fire only at rare intervals. It is perhaps not surprising that he gives more attention to dollars than to life safety.

Whenever recommendations are made for improvements in buildings to increase safety from fire, except perhaps in the immediate period after a disaster, the question is asked, "How much will it cost?" and there is resistance if the expense amounts to any considerable sum. There is no limit to the amount of money spent for improvements in buildings that will produce more income, but, except in the short-lived hysteria following some major fire catastrophe, the expenditures for fire safety are woefully limited. When we advocate the installation of automatic sprinklers to improve fire safety in hotels, the reaction is apt to be: Will the savings in fire insurance pay for the sprinklers? If the answer is no, all too often the sprinklers are not installed. So far as something can be done by posting signs and making minor repairs to defective equipment, well and good, but when it develops that real life safety involves some substantial expenditure, the enthusiasm for fire safety seems soon to evaporate.

In our approach to the fire problems, we should be realistic. While we deplore the resistance to expenditures for life safety from fire, we must realize that it is not possible to secure 100 per cent safety. One hundred per cent safety would make buildings so expensive that we couldn't afford to live in them. There must be some practical compromise. We must be reasonably safe, but we cannot have safeguards so expensive that they cannot be observed without depriving ourselves of places to live and sleep. It is, however, fully practicable to achieve reasonable fire safety without prohibitive expenditures, through proper planning.

Much has been accomplished to increase life safety from fire through laws and regulations. All should agree that the exercise of the police power in the interest of public safety is a proper function and should be extended. However, no law can be truly effective unless it is accepted as reasonable by the great majority of those whom it affects. Regulatory legislation in general is effective to the extent that it specifies the things that most of the people would do of their own volition and exercises the element of compulsion only upon a small recalcitrant minority.

Thus, in legislation in the interest of fire safety, it is futile to attempt perfection. We have to steer a middle course and specify not what is perfect but what we know can be enforced with some reasonable degree of public acceptance. Any attempt to provide 100 per cent safety is likely to lead only to disregard and evasion of the law, with no general improvement in public safety. Actually, the improvements in public safety that stem from legislation are not so much due to the law as to the educational efforts of state and municipal law enforcing agen-

cies in the fire field, whose inspectors have generally found it much more effective to operate through persuasion, making the building owner realize that the measures recommended are in his own interest and invoking the penalties of the law only in the case of the occasional recalcitrant individual.

Intelligent use of fire safety legislation and constantly increasing efforts for further public education offer the best possibilities for reducing loss of life by fire. These measures, however, at best can produce only slow progress, and so long as the dollar looms larger in the public mind than human life, we probably must expect for many years to come a continuance of this tragic list of fire disasters. We can, however, do much to reduce their number, and it behooves every member of the National Fire Protection Association in his daily activities to do all that he can to make those with whom he comes in contact fire conscious and to secure correction of individual hazards whenever he encounters them.

A starch dust explosion in Pekin, Ill., where 42 were killed on January 3, 1934. This and other fatal dust explosions led to the development of N.F.P.A. code for the prevention of dust explosions and a greatly improved record in recent years.

Urban Disintegration.

By Leon M. Gurda,
Inspector of Buildings, Milwaukee.

Fires in obsolete and dilapidated buildings are one symptom of the vast physical deterioration which is undermining our urban way of life. For several decades, we have been engaged in endless surveys, research and studies of the causes of urban disintegration, seeking new patterns to halt this obvious economic urban waste. The science of city planning as applied to modern urban development began to take new forms with the close of the nineteenth century. Even now, new unpredictable forces are at work which we as yet do not fully understand. If we are to restore some semblance of urban economic stability within our cities, we must seek and adopt remedies which will put an end to our urban stagnation and physical deterioration. The checking of the growth of blight in our cities requires something more than talk, streamlining of zoning and building code regulations and master planning.

Property Rights.

The inviolability of property rights has always been jealously guarded. Because of this, legislation regulating the use of property and urban development has restricted such rights only to a minor degree, with obvious results. However, the public is becoming more and more conscious of the apparent need for the rebuilding of our cities and the enactment of measures to improve urban environment in all its phases. In our case, petitions to the Common Council to take appropriate action to abate nuisances which cause our citizens discomfort, expense, and annoyance substantially increase in number from year to year, disclosing without any doubt the urgent need for the elimination of evil conditions. Similar conditions are found in all other American metropolitan areas.

Zoning.

The idea of zoning of municipalities is more than thirty years old. This type of control of physical development has run the gamut of opposition, and of judicial interpretation and determination of zoning regulations as they relate to property rights. With the adoption of zoning, we believed that the evils of urban life would come to an end. However, experience with zoning regulations clearly shows that the desired objectives have not been attained. In fact, the establishing of large areas for industrial, commercial and business purposes far in excess of the need for such areas, with minimum provision for open spaces, providing for unreasonable densities of population in all of our mixed occupancy areas, and avoiding regulations which would check the chaotic development in the older sections of our cities, has tended to aggravate conditions and create undesirable urban environment.

We now believe that zoning must be strengthened and that in addition to effective zoning, we must evolve other measures which will assure a better, more satisfactory urban environment.

Obsolescence in industrial, commercial and housing areas, the skyscraper fad, the junk yards, promiscuously located parking lots, the modernization of store fronts (concealing rundown and dingy upper

floors of outmoded buildings), lots used for storage purposes and many other evils are problems which cannot be ignored.

New City Developments.

New city developments and the rebuilding of our cities must be of sound physical, economic and social value centering around three major factors: (1) habitation, working facilities, traffic; (2) land values, service costs, taxation; (3) child raising, health and recreation, social satisfactions. A master plan and a sufficiently flexible zoning ordinance embodying these factors must be evolved. However, let us not be overly optimistic and again repose in the belief that the master city plan when adopted with an effective zoning ordinance will bring about the removal of physical decay, obsolescence and improve urban conditions; such will not be the case.

We in Milwaukee have developed a long term improvement program. For the execution of this program, we now have approximately $15,000,000. But, and here is the rub, most of this money is earmarked for needed municipal improvements having little to do with the rebuilding of our city. Let us not create a "civic center paradise" as an oasis in a vast area of deterioration. Let such a development be only the first step in the plan of rebuilding. The second step brings us face to face with a hard, uncompromising reality. In this step, both the city and private enterprise must do their share.

Use of Obsolete Buildings.

We find in the practice of private enterprise that obsolescence, wear and tear of physical property, is provided for with a view of the replacement of such property when conditions warrant such replacement. But when a municipal permit is issued for the construction of any building or structure, it is issued without any restrictions as to the length of time the building may be used, or its maintenance, except for minimum requirements relating to safety and sanitation.

We do have authority under the police power to order an owner of an unsafe building to either make it safe or to raze the building, or in the event the building is unsanitary to close such a building and prevent its use until it is made sanitary and fit for occupancy. However, there is a twilight zone in the life of every building. That zone may continue for periods of time ranging from five to fifty or more years before action can be taken for its removal or closing under present laws. Are we to tolerate buildings which for lack of maintenance become blighted and affect values of adjacent properties, thereby affecting also the property rights of owners of adjacent buildings which are properly maintained? Or will we devise some method under which it will be mandatory to maintain properties at recognized standards whether such standards be as of today or of fifty years hence?

Planning for the Future.

Who knows what economic, social, health, housing, public safety, as well as general public welfare standards will prevail fifty or a hundred years hence? I believe that if our forefathers had foreseen the automobile and all the present day traffic problems, the kind of housing we now need, urban congestion, the need for recreational areas to preserve health, public safety in today's way of life and many other problems which surround us, being human beings just as we are, they would have done some serious thinking, and I for one am willing to believe that their planning would have been such as to make

our problems lighter. Why cannot we now plan intelligently so that the generations to come will not be confronted with even weightier and more serious urban problems?

Time-Limit Building Permits.

Why do we continue the practice of granting permits for buildings to stand indefinitely, when such buildings, no matter how good today, may impose serious problems on future generations? Buildings are ordinarily designed and financed on the basis of some anticipated period of useful life. Why not limit the life of the permit accordingly and, say 50 years hence, let the authorities then in charge decide what should be done? There should be no hardship upon the owner of a building now erected if the building permit which he received specified that at the end of say 50 years, he must raze the building or modernize it to comply with all then existing legal requirements. It is certain that at the time of the expiration of such permits, the further use of the building or structure would be permitted, if it had been properly maintained, and of further functional use based upon the requirements of that time.

There are many questions which should be considered before adoption of legislation requiring time-limit permits, including the effects on financing and on assessed valuations and taxed revenues, the practical aspects of enforcement, the extent to which such legislation might be applied to existing buildings, and the probable results in preventing obsolescence and nuisances, and in preserving further health and safety. It seems clear that such legislation, properly drawn, would be upheld by the courts as valid.

It is obvious that any such legislation would need to be comprehensive in scope, but once adopted would need to be inviolable in character except for amendments to correct inadequacies and inequities based upon experience in its administration.

Board of Directors' Action.

The Board of Directors, as of September 5, by letter ballot, approved amendments in the Standards on Fur Storage as adopted at the 1947 annual meeting on recommendation of the Committee on General Storage as follows:

(a) Rearrange the sections so as to place them in the following order:

I. Vaults for Fur Storage.
II. Vault Operation.
III. Building Construction.
IV. Building Hazards and Operation.
V. Protection of Building.

(b) Reword the paragraph headed "Application" as follows and place it just before the renumbered Section III, Building Construction.

"The following sections III, IV and V apply to buildings occupied principally for the handling, processing and storage of furs. It is desirable that all buildings housing fur vaults conform to these sections in so far as practicable."

Rural Fire Inspection.

By L. G. Keeney.*

Prevention of farm fires provides a direct avenue to loss reduction, but results are elusive and difficult to measure, and there is little opportunity to call attention to fires which never start.

Rural fire department protection is very valuable, and the NFPA Committee on Farm Fire Protection should be commended for their continued efforts in the promotion and development of adequate rural fire fighting apparatus.† It is hoped that the number of rural fire departments will be increased and that improved equipment and training of firemen will continue to reduce fire waste throughout the nation.

However, it is generally conceded that fire fighting alone is inadequate for farm communities. At the time of the year when the more serious fires are prevalent, weather and road conditions are uncertain. Farms which are not quickly accessible from towns or villages with fire protection equipment and personnel face uncertain conditions when weather and roads are favorable, and their case is hopeless when the elements are against them. Inadequate water supplies also aggravate the protection problem. Dependence on some remote fire department often encourages a false sense of security among farm owners. These considerations all emphasize the importance of fire prevention and of such water supplies and fire extinguishing equipment as the farmer himself can provide.

Farm Fire Losses.

An intelligent approach to the potentialities of loss control by inspection is obtained from a study of fire loss statistics. A research program has been in effect in Iowa for more than fifteen years, which has included analysis of more than 30,000 rural fires. We have found that 94 per cent of the fire waste involves the two principal farm buildings. Dwelling loss accounts for 62 per cent and barn loss 32 per cent. It is therefore obvious that our program of prevention should be directed toward these major buildings.

We have found in Iowa that most fires start in the more expensive buildings — the dwelling or the barn. Newspaper reports, "Adjoining buildings were saved by fire fighting equipment," become less important when we consider that the building in which the fire is most apt to originate may represent 30 to 50 per cent of the total investment in buildings.

A complete reversal of the generally recognized causes of fires throughout the nation is apparent in the study of farm fires in dwellings and barns. For example, matches and smoking represent a serious cause on a nationwide basis, but are relatively unimportant in Iowa farm fire loss. The majority of dwelling fires from known causes results from construction deficiencies—either improper construction, which is well within the control of the owner and builder, or deterioration of physical equipment after years of usage.

*This article is an adaptation of a paper presented at the December, 1946, meeting of the NFPA Committee on Farm Fire Protection by Mr. Keeney, Secretary, Farmers Mutual Reinsurance Association, Grinnell, Iowa, and member of the Committee.

†Volunteer Fire Departments for Rural and Small Community Service. 1947, NFPA, 50c.

The principal known causes of farm dwelling fires are listed in their order of importance as follows:

Cause	Per Cent	Annual Aver. Loss.*
Defective flues and heating systems	43	$350,000
Defective roofs	30	240,000
Defective wiring	6	60,000
Defective gasoline and kerosene stoves	5	45,000

Similar analysis of barn fires shows the following:

Cause	Per Cent	Annual Aver. Loss.*
Spontaneous ignition of hay and straw	43	$170,000
Lightning (unrodded barns)	29	130,000

Hazards.

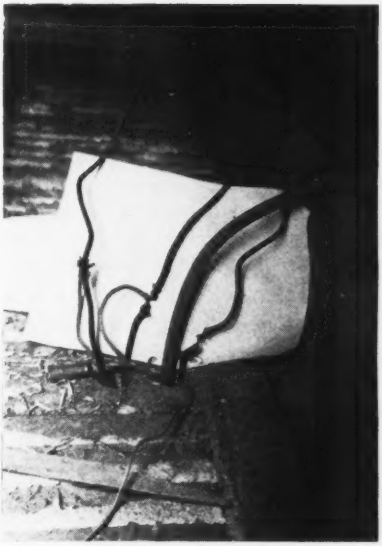
During recent years we have attempted to correlate the fire records with the hazards, by analyzing thousands of individual inspection reports.

During the early years of our inspection, it was found that more than 20 per cent of farm dwellings were seriously endangered by sub-standard chimneys, furnaces and heating equipment. Many chimneys were not accessible for inspection in attic spaces.

Inspections during the years 1934 to 1938 showed that approximately 40 per cent of Iowa farm dwellings had old weathered wood shingle roofs in definitely dangerous condition.

Some 52 per cent of the dwellings and barns were equipped with lightning rods, but only 20 per cent of the cribs and other sizable service buildings were rodded. Twenty per cent of the lightning protection systems on dwellings were seriously defective, 29 per cent of the systems on corn cribs were sub-standard and nearly 50 per cent of the lightning protection systems on barns were out of order. As barn lightning protection systems are subject to the most severe mechanical injury, it appears that deterioration of these systems is less important than damage done by livestock and machinery.

*State Fire Marshal records (1930-1937).



Electrical wiring found in dwelling attic. Additions made by owner as power needs increased.

In the early years of our inspection program, the electrical wiring situation was astounding. The loss from electrical causes was relatively unimportant only because few farms had electrical service. Early summaries showed us that 80 per cent of our farm electrical systems were overloaded, without proper overload protection. Fully half of the interior wiring systems were sub-standard due to the use of improper materials and poor workmanship.

Selection of Inspectors.

The type of men employed as inspectors will mean either success or failure for the enterprise. Most important, the inspector should have a farm background, be conversant with farm problems and be able to appreciate the position and the viewpoint

of farm people. Courtesy and tact are vital. An inspector must have the ability to accomplish improvements by convincing his clients that his recommendations will operate to their benefit. Our most dismal failures have resulted from the employment of men who overrated their authority as inspectors.

Technical education and mechanical ability are valuable assets for an inspector.

Careful supervision and training of inspectors are essential. We have found that periodic training conferences held for the purpose of providing the inspector access to the information which he needs and to promote consistency and uniformity throughout the entire staff are valuable. Our inspection staff is directed by a mechanical engineer whose entire time is spent in training and supervising field operations.

Inspection Equipment.

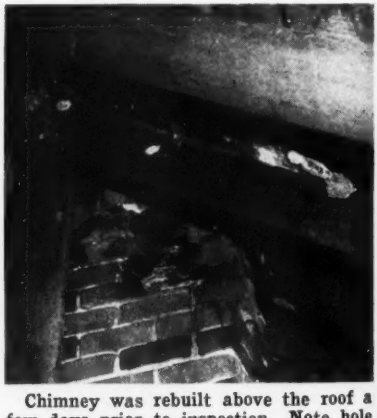
Our present inspection equipment resulted from years of experimentation. Automobiles with ladder racks were first used, after which specially built trailers were developed. At present we use standard pick-up trucks which are equipped to carry ladders, spark arresters, tools and repair materials.

Each pick-up truck is equipped with telescopic ladders consisting of five sections, each six feet in length. A small folding ladder is used to gain access to attics and other points within the building. Two of the six-foot sections are equipped with roof cleats so that the inspector may scale any ordinary roof without danger of injury.

Inspectors remedy many serious defects while they are on the premises. Lightning rod repairs are made, spark arresters and flue stops are installed, defective and poorly insulated electrical connections are repaired, time-lag fuses are installed and other simple repairs are completed to avoid the need for rechecking the property at a later date.

Inspection Standards.

Establishment of uniform inspection standards to apply throughout Iowa has required continuous effort. Although minor hazards have not been neglected, it has been necessary to concentrate on the defects and conditions which appear to be most important from the standpoint of fire loss. All inspectors are required to follow uniform standards and to evaluate each farmstead and each individual building on a consistent basis. In general, standards of the National Fire Protection Association have been followed rather closely; certain deviations have appeared to be necessary to meet situations found on the farm. There are cases where it is necessary to concentrate on one, two or three extremely serious hazards in an effort to make sure that they are remedied, while merely calling attention to less serious hazards which might be emphasized on another farm.



Chimney was rebuilt above the roof a few days prior to inspection. Note hole left in chimney in attic space which mason neglected to inspect due to attic inaccessibility.

This chimney was in use when inspector found hole by inspection of chimney in attic space.

Standard brick chimneys are required for heating and cooking equipment. Such makeshifts as ordinary metal pipes which pass through roofs or through concealed attic spaces have been eliminated altogether. All chimneys are inspected above the roof, in the attic and other visible locations. If the chimney in question is defective at one visible point, it is assumed that it is also defective at points where inspection is not possible. Concrete block chimneys have been rejected if there is any possible question as to their condition. We have found concrete block chimneys which have deteriorated until their walls are less than one-half inch thick. Recommendations always include the provision of openings into concealed attic spaces to permit proper inspection. All unused flue openings are required to be closed with concrete or by installing an insulating flue stop.

The usual standards relating to the installation of heating units are followed religiously. During recent years, many automatic electric blowers have been installed on hand-fired warm air furnaces. A number of fires have occurred as a result of this combination and our staff has taken a positive stand against semi-automatic heating systems. The obvious danger is that the blower may fail to operate due to power failure, worn belts or other reasons, with the result that the system will overheat immediately.

Chimney spark arresters are installed by inspectors on all dwellings with wood shingle roofs. The spark arresters are regarded as a temporary expedient until such time as a fire-retardant roof covering can be installed. Fortunately, many wood shingle roofs are being replaced with fire-retardant coverings, and we hope that the wood shingle roof hazard may ultimately become unimportant. Incidentally, installation of spark arresters has made farm owners aware of the roof fire hazard to the point that most of them naturally replace the wood shingles with safer roof covering.

Weathered wood shingles on farm dwelling.

Rural Electrification Administration educational programs as well as increased interest in safety by utilities companies have, in general, improved the wiring standards in farm communities. We have endeavored to make farm owners aware of the dangers resulting from overloaded circuits; our inspectors have installed thousands of time-lag fuses which will withstand the temporary overload resulting from starting electric motors. Where

Gasoline and oil storage in barn. Note drip pan and oil-soaked rag.

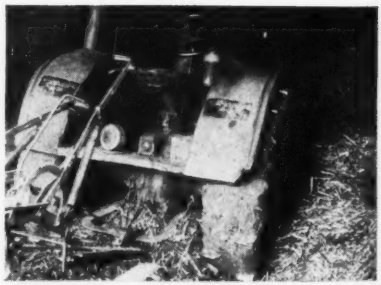
circuits are obviously overloaded, recommendations are made for the addition of circuits to provide extra capacity. Reinspection of electrical systems after three, four or five year intervals indicates that corrections of mechanical injuries are prime considerations in the future. Periodic examination by a trained inspector seems essential.

Inspection of lightning protection systems on farm buildings is now a major activity. Examination and repair of basic lightning protection systems is comparatively simple, but the interconnection of metallic equipment, such as hay tracks, door tracks, litter carrier tracks, metal stanchions and fixed electrical equipment, presents complications. A further problem is that most of the electrical systems were installed in farm buildings years after the lightning rods were installed. Electricians seem to have little knowledge of the principles of lightning protection, with the result that some serious situations developed. The installation of electrical equipment in buildings requires that the electrical system and the lightning protection system be coordinated for the sake of safety.

The chief development of interest in recent years in flammable liquid handling is the tendency to provide outdoor storage facilities. Admonitions from inspectors against the practice of storing gasoline and other fuels in farm buildings, generally result in separate fuel sheds being provided located well away from major buildings.

Of major concern to us is the practice of using artificial heat to dry hay and grain. Much sub-standard equipment has been used for this purpose and farmers have been the victims. For example, the 1945 growing season was extremely unfavorable, as the corn crop was planted late and was exposed to very little favorable drying weather. Farmers were easy prey for equipment dealers with drying equipment which was reported to perform miracles in reducing moisture content.

One corn drying "specialist" visited our state and advertised to the farmers that he could dry a crib of corn in not more than ten hours. He used a homemade oil-burning unit which was attached to the end of a crib by means of canvas. After a few hours of operation, the corn nearest the burner appeared to be fairly dry, although moisture tests taken the following day indicated the same amount of moisture as was present before the test began. This particular operator attempted to dry the first crib, burned the second and left



Tractor stored adjacent to hay in an Iowa barn.

Iowa for parts unknown. The types of equipment used for grain drying are so numerous that it is difficult to establish standards which are applicable to all cases. However, we have been forced to adopt very rigid requirements in an effort to discourage fly-by-night manufacturers who are overly enthusiastic about their equipment.

At the conclusion of each inspection, the inspector's findings are written in nontechnical terms on an inspection certificate which is left with the farm owner. The proposals are separated into two categories; first, required alterations which warrant reinspection at a given time; and second, certain suggestions for the improvement of fire safety about the premises. Finally, an illustrated leaflet treating the subject of fire prevention in a general manner is left with the farm owner. We have been surprised at the number of suggested improvements which have been made because the inspector took the time to discuss problems peculiar to a particular farm and left precise suggestions to the owner.

Loss Reduction Results.

Since 1934, our staff has completed inspections of 130,000 Iowa farms. Most localities have established permanent plans for reinspection at five-year intervals. Sufficient territory has been covered to indicate not only past accomplishments but future possibilities.

During recent years the national fire loss has mounted consistently. According to the information at hand, farm losses in many states have followed the national pattern. The period from 1930 to 1934, inclusive (prior to the inauguration of our inspection program) produced farm fire loss in Iowa in an average amount of $3,075,000 per year. This loss represented a yearly average of 624 dwelling fires, 296 barn fires, and a total of 1,368 farm fires.

By way of contrast, the four-year average from 1940 through 1943 resulted in total fire loss of $1,350,000 per year, representing 303 dwelling fires, 146 barn fires, and a total of 648 farm fires. The 1944 farm fire loss amounted to slightly over one million dollars. Nineteen hundred forty-five and 1946 each produced losses of less than $1,500,000, in spite of inflated values.

Rural fire inspection appears to be justified on the grounds that fire protection alone is inadequate, that the nature of farm fire waste indicates that it may be controlled by preventive measures, and finally, that loss reduction records in communities where intensive farm inspection programs have been carried on tend to prove the value of inspection beyond doubt. An effective rural inspection program may be provided through the aid of carefully chosen and well-trained inspectors who have the equipment, facilities, and technical standards at their disposal which are necessary for a practical approach to loss prevention. Farm fire prevention will never be sensational and its results will be difficult to measure. However, detection and elimination of causes which are known to produce the majority of farm fires cannot help but produce lasting results.

Fire Problems in Radiochemistry.

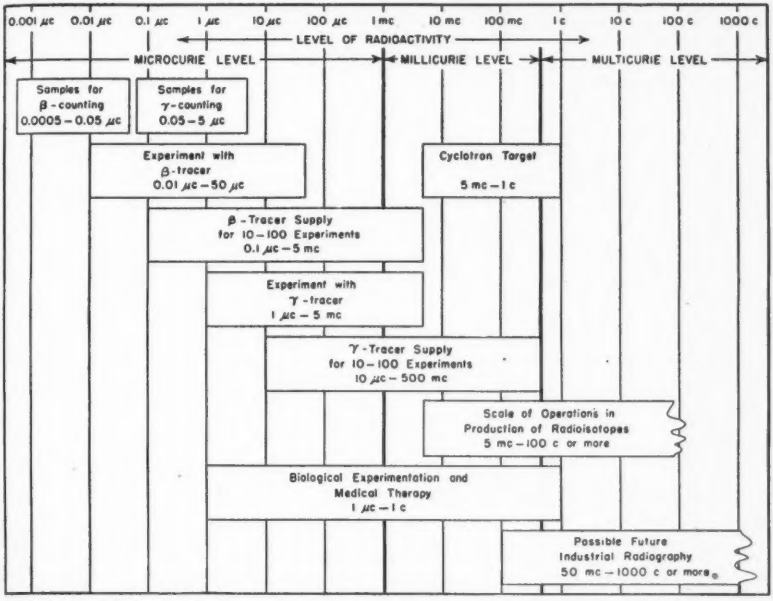
While the atomic bomb has received most of the headlines, developments in radiochemistry are going ahead with important applications, chemically, biologically, medically and technologically. Like every new development, this has brought up fire problems to be solved. It appears that there is at least one new situation in the dangers which come from the radiations of the new chemicals involved.

So far, the principal experience with these hazards has been in connection with the Manhattan Project, out of which came the atomic bomb. Now the handling of radioactive materials is likely to be encountered in chemical laboratories, hospitals, colleges and in industry. There are likely to be an increasing number of places where radiochemical research will be carried on so that it will involve problems to be faced by fire protection engineers and fire fighters. *Business Week* (March 29, 1947) mentions three companies which have various atomic research projects going on at five locations: Fairchild Engine and Airplane Co., at Hagerstown, Md.; General Electric Co., at Hanford Engineering Works in Washington State and at the Atomic Energy Commission's Laboratory at Schenectady, N. Y.; and Monsanto Chemical Co. at Clinton Laboratories, Oak Ridge, Tenn., and the Atomic Energy Commission's Laboratory, Miamisburg, Ohio. There is also, *Business Week* reports, a Nuclear Energy for Propulsion of Aircraft Project. The Fairchild Engine and Airplane Company's activities are part of this. Other parts of the project's research are located at Oak Ridge, at the National Advisory Committee for Aeronautics in Cleveland, at the Massachusetts Institute of Technology, in Cambridge, Mass., at Frederic Flader, Inc., Tonawanda, N. Y., at Northrup Aircraft, Burbank, Calif., and at Battelle Memorial Institute, Columbus, Ohio. This illustrates the geographical extent of the activity and suggests that in a short time no part of the country will be far from some center at which there are the problems of radiochemical laboratories.

Hazards.

Mr. Henri A. Levy of the Monsanto Chemical Company, Clinton Laboratories, at Oak Ridge, Tennessee, gives a clue to the nature of some of the fire problems in discussing the subject "Some Aspects of the Design of Radiochemical Laboratories" in *Chemical and Engineering News* (Vol. 24, No. 23, pages 3168 to 3173). He has the following statement to make about the hazards encountered in radiochemical laboratories.

> The same characteristics which make radioactive materials so powerful a tool to research and development also render them among the most hazardous encountered by the chemist. All of the notorius hazards of the radium industry will be associated with the use of these new substances, and furthermore may be magnified manyfold because of the vastly larger quantities of pile-produced radioactivity available.
>
> Radioactive substances are dangerous in extremely minute quantities when inhaled or ingested, and in somewhat larger quantities through the external effects of their radiations. Toxicity varies from one isotope to another, depending among other factors on the type of radiation emitted, the half-life, the mode of metabolism of the element, and the rate at which it is eliminated from the body. The alpha-emitters of intermediate half-life (less than 10^5 years) are among the most toxic. Of these, plutonium constitutes a "horrible example" whose extreme toxicity is illustrated by the fact that the tolerance amount of the substance when


0.001 μc
0.01 μc
0.1 μc
1 μc
10 μc
100 μc
1 mc
10 mc
100 mc
1 c
10 c
100 c
1000 c
LEVEL OF RADIOACTIVITY
MICROCURIE LEVEL
MILLICURIE LEVEL
MULTICURIE LEVEL
Samples for β-counting 0.0005–0.05 μc
Samples for γ-counting 0.05–5 μc
Experiment with β-tracer 0.01 μc–50 μc
Cyclotron Target 5 mc–1 c
β-Tracer Supply for 10–100 Experiments 0.1 μc–5 mc
Experiment with γ-tracer 1 μc–5 mc
γ-Tracer Supply for 10–100 Experiments 10 μc–500 mc
Scale of Operations in Production of Radioisotopes 5 mc–100 c or more
Biological Experimentation and Medical Therapy 1 μc–1 c
Possible Future Industrial Radiography 50 mc–1000 c or more

Chemical and Engineering News.

Approximate range of radioactivity encountered in principal classes of radiochemical work. The boundaries of the various boxes are to be taken as typical illustrations only. Note the large proportion of boxes in the lowest category of radioactivity.

fixed in the body tissues is only 0.5 microgram.

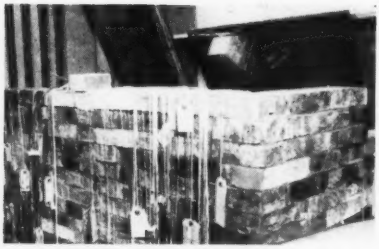
Effects of external radiation may be either acute, produced by brief exposure to high intensity sources, or chronic, produced by repeated exposure to relatively modest sources. The second of these is exceedingly insidious: repeated mild exposures may give no visible evidence of damage; yet years after exposures have ceased, exposed tissue may become cancerous.

Biological experimentation both within and outside the Manhattan Project has resulted in the adoption of a tolerance dosage of radiation believed to be safe even for indefinitely repeated exposure; this dosage is 0.1 roentgen per day. The roentgen is defined as that quantity of radiation which falling on dry air under standard conditions produced 1 esu of ion pairs per cubic centimeter. Excellent instruments are available for detecting, measuring, and recording intensity of radiation and exposure; with their use avoidance of overexposure is practical and convenient.

Mr. Levy goes on to explain that the radiation hazard depends on both the quantity of radioactive substance as measured by disintegration rate, and on the quality of the radiations, whether alpha, beta, or gamma, regardless of energy range. He says that since alpha-rays are very easily absorbed in air or by ordinary laboratory vessels, the external radiation hazard with alpha-emitters is of little importance. He, therefore, treats equipment and techniques appropriate to alpha-radiation separately from those for the more penetrating beta and gamma-rays.

Levels of Intensity.

For beta and gamma-rays, he points out that it is useful to classify techniques as appropriate for slightly active, moderately active or highly active samples. He says that laboratory facilities and techniques have been found to fall naturally into



Chemical and Engineering News.

Radioactive samples are stored in lead-lined lockers or behind a lead barricade (illustrated).

three categories whose division points can be roughly defined in terms of radioactive intensity.

a. The microcurie level, covering activities up to 1 millicurie.

b. The millicurie level, ranging from 1 to about 500 millicuries.

c. The multicurie level, covering activities greater than about 0.5 curie.

Mr. Levy goes on to describe the details of the laboratories and laboratory facilities and equipment for various types of research at the three levels. From these, it can be seen that there are three general types of problems which are also fire problems. The first of these relates to the protection of personnel, which must, of course, include fire fighters. The second deals with the disposal of water and waste, which must necessarily include water used for fire fighting. The third factor has to do with control of the air in the laboratory rooms, which brings up all of the fire problems of air conditioning.

Protection of Personnel.

Mr. Levy describes instruments to be provided to detect radiation contamination in clothing or on the skin. He points out that there must be a routine monitoring of the degree of exposure to the various rays. All personnel working in the neighborhood of the laboratory would be required to wear pocket radiation meters which are read daily, and records of the exposures should be kept for future reference. At the microcurie range, it is necessary to protect the hands and this is accomplished by the use of tongs in handling samples.

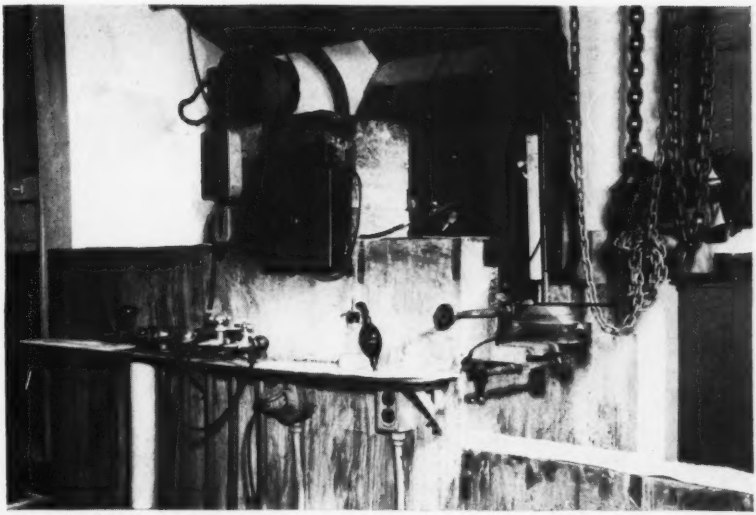
At the higher ranges, all work has to be done by remote control with the personnel staying behind lead and concrete barriers. Fire fighters, too, would have to stay behind these barriers and this would require that fire protection apparatus be operated by remote control.

Disposal of Waste.

The laboratories where highly radioactive operations are carried on require special sinks wasting to an underground diversion tank. Mr. Levy's article does not go into details of the ultimate disposal of the waste except to say that waste is sent to a special underground storage tank if the water is dangerously radioactive. He suggests that an investigation be made of the safety of the use of ordinary drains, which he thinks permissible for radio-

Chemical and Engineering News.

Chemical operations at high activity levels are carried on in concrete cells with 2-foot walls such as the one illustrated above. Door is steel-encased lead 6 inches thick. Manipulatory instruments are operated, through the wall in various ways, from outside.



Chemical and Engineering News.

Radiochemical operations at intermediate levels of radioactivity are carried on behind an elevated, shielded hood. The working volume in the arrangement shown is a well-lighted space, having walls and floor of lead 3 inches thick and lined with stainless steel sheet. The front barrier of lead is 6 inches thick. Visibility is provided by a tilted mirror placed above and at the back of the hood. Hood vents of stainless steel withdraw fumes either close to the floor or close to the ceiling, using a high capacity fan. Hoods are not very deep. Depths of 1, 2, and 3 feet have been provided at Clinton Laboratories.

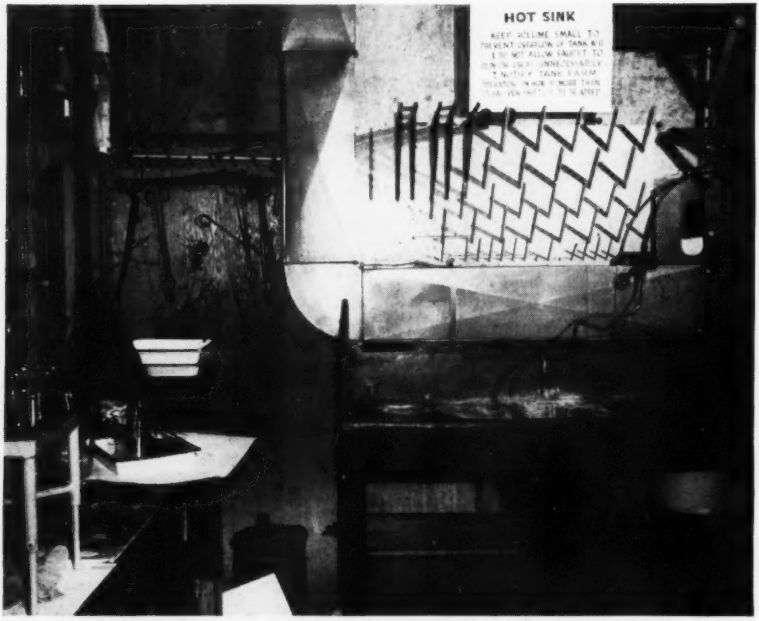
active wastes from operations on the microcurie level.

Where water is used for fire fighting, it is probably necessary to assure that it, too, is not allowed to reach the regular drains until its safety or danger, radioactively, has been determined.

From a fire protection view, this may not bring up any strictly new problems, as there are well-established techniques for the disposal of water from automatic sprinklers through the waterproofing of floors and by use of special drains. Areas behind barriers in which radioactive samples are manipulated should be provided with drainage facilities so arranged that water from these areas, which may get there as a result of fire-fighting operations, will be drawn off in the same manner as the dangerous waste water from sinks.

Air Conditioning.

It appears from Mr. Levy's account that with emitters of purely alpha-radiation such as plutonium, the hazard of external radiation is absent, unless the material is in direct contact with the skin, because of the short range of the particles. This hazard, however, is replaced by the equally serious one of extreme toxicity. It is necessary to take extreme precautions against ingestion and inhalation of even minute quantities of the material. Consequently, in plutonium work, chemical operations must be performed inside well-ventilated hoods. It means that nearly all working space in the laboratory would be in the form of hoods. It is necessary, therefore, that a dust-free atmosphere be maintained, since Mr. Levy indicates that plutonium is easily absorbed on dust and



Chemical and Engineering News.

A so-called "hot sink." Drainboards and bowl are lead-lined. Hot and cold water are supplied by knee-operated valves, and drain leads to an underground diversion tank.

is easily transported and less easily eliminated in that form. An entire plutonium laboratory must be under forced-ventilation and separated by an air lock from the rest of the building.

With beta and gamma operations, hoods are required over the space behind barriers where apparatus involves operations at the millicurie or multicurie level. Special air conditioning is also required in instrument rooms where radiation counting apparatus is installed.

Radiochemical laboratories, therefore, will have air conditioning systems which apparently must embrace certain features of design to carry off dangerous vapors. It is said, however, that the atmospheres may be moved through apparatus which will draw off the dangerous charges.

From the fire protection point of view, however, air conditioning systems should be designed with the usual features to prevent the spread of fire from one area of the building to another. A point worth investigating might be to see that the apparatus has sufficient capacity to deal with charges which may accompany smoke particles.

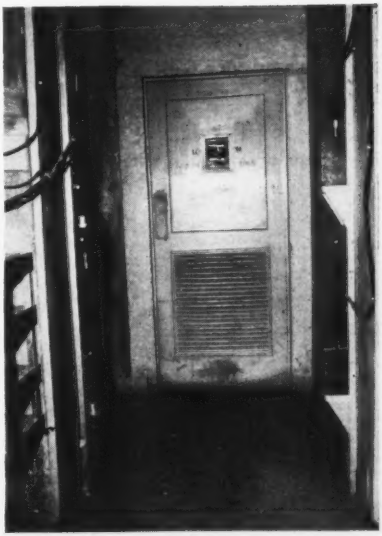
Firemen, called on to fight fires in laboratories, may encounter contaminated air or smoke. Fire protection engineers of the Atomic Energy Commission emphasize that firemen have no natural means of detecting the presence of dangerous radiations. They recommend, therefore, the use of respiratory protective equipment of the sort that furnishes its own oxygen. Respirators or masks, in their opinion,

may be unsuitable, as the manufacturers apparently do not claim that conventional fire service masks, depending on a filtering process, can insure safety from dangerous radiations.

Building Construction.

In case of fire, if radiochemical operations are carried on in buildings involving any appreciable amount of combustible construction, or contents in the form of furniture, equipment and trim, an entire area might be so badly contaminated as to involve a severe hazard to a great many people and perhaps to make it difficult to continue the particular research in the vicinity because of the contamination. This possibility seems clearly present unless the arrangements to control all of the smoke which may be given off from a fire are built into the structure and unless there is suitable provision for taking care of all water that may be used in fighting fires.

It seems desirable that arrangements for fire fighting should be built around the controlled use of minimum amounts of water. Manual fire fighting with hose streams should not be necessary. Where there are combustible roofs (as reported in some of the one-story laboratory buildings used in various parts of the Manhattan Project), automatic sprinkler protection should be employed. In such cases, dangerous areas probably should be so arranged that in the event of fire in these areas, the sprinklers (or special water-spray apparatus) would deal automatically with the fire, the water being carried off by drains of adequate capacity to handle the amount that the fire-fighting operations may require.



Chemical and Engineering News.

A doorway for detecting persons passing with radioactively contaminated clothing. Five Geiger-Müller counters surrounding a doorway are connected with an alarm circuit which operates when excessive radiation is present.

In modern laboratories, there seems to be no reason why the fire hazard might not be effectively minimized by reducing the total amount of combustible material in equipment and furniture. For these dangerous processes, buildings of completely fire-resistive construction are essential.

Ammonium Nitrate Fertilizer.

Interim Report.

Since the publication of the Texas City Disaster report in the July, 1947, QUARTERLY, there have been several developments of international interest concerning the handling of ammonium nitrate fertilizer, and the explosion at Brest, France (see page 115), has further focused attention on the hazard. It is the intent of this article to report briefly on the findings of the several agencies which have issued recent reports or held public meetings. The information provided here should be regarded only as an interim report. As further action is taken, N.F.P.A. members will be advised through the publications of the Association.

Interagency Committee Report — Part I.

Following the Texas City disaster (April 16, 1947), the Commandant, U. S. Coast Guard, requested the Secretary of the Treasury to appoint a special committee composed of all the various federal departments concerned with the production, transportation, and use of ammonium nitrate fertilizer for the purpose of thoroughly investigating its fire and explosion hazard and promulgating the necessary safety regulations. Mr. William T. Butler, Chief of the Hazard Prevention Section, Merchant Vessel Inspection Division, U. S. Coast Guard, is Chairman of the group.

Part I of their report,* issued under date of August 20, 1947, precedes publication of two subsequent parts which have not to this date (October 8, 1947) been released. Part I deals with the hazardous properties of ammonium nitrate fertilizer of the type involved in the fires and explosions at Texas City, together with information as to its hazards in marine transportation and recommendations to attain maximum safety in handling and stowage aboard vessels. Part II will deal with the hazards of land transportation and stowage. Part III will discuss the chemical and physical tests being conducted on the material by several governmental laboratories.

The following excerpts from Part I should be of particular interest, and give information supplementing the report on the Texas City Disaster in the July, 1947, QUARTERLY.

"In the committee's opinion, it is necessary to change the chemical stability of ammonium nitrate fertilizer to cause its explosion or detonation under conditions associated with its transportation as cargo. This chemical stability can be altered by the application of heat to a sufficiently high degree or by involvement of the fertilizer in a fire of combustible materials under certain conditions, that is, confinement in a compartment which lends itself to the retention of heat and the building up of pressure generated by the products of decomposition. Excessive temperature and pressure create a dangerous condition in the storage or stowage of ammonium nitrate fertilizer, and in the opinion of the committee are the key factors that can cause the substance to explode or detonate."

Regarding the explosion of the S.S. *High Flyer* at Texas City, the following excerpt is of particular significance:

"As a practicable consideration, it appears justifiable to assume that considerable sulfur dust was deposited on and in the *High Flyer*. The presence of bulk sulfur adjacent to the hold in which the ammonium nitrate fertilizer

*Published by the Treasury Dept., U. S. Coast Guard, Washington, D. C.

was stowed, and the possibility of sulfur dust being present in the No. 3 lower hold, cannot be discarded, and the committee is inclined to accept the presence of the sulfur as a contributing cause to the detonation of the ammonium nitrate fertilizer cargo under influence of the fire in the *High Flyer*."

This theory has been substantiated by tests conducted by the Bureau of Explosives with admixtures of 10 per cent sulfur with the fertilizer. Additional tests and their findings will be covered in Part III of the Interagency.

Some other important portions of Part I are paraphrased. The committee recommends continued study of shipping containers with a view to reducing their combustibility without increasing the hazard; requests the Interstate Commerce Commission to promulgate a specification for paper bags used for shipments of 100 pound quantities; concurs in the necessity for yellow labels for ammonium nitrate fertilizer, guanidine nitrate, and calcium nitrate for shipments by vessel; recommends a regulation prohibiting the stowage or transportation of ammonium nitrate fertilizer on board a vessel which also has sulfur; requires the thorough cleaning of holds previously used in transporting sulfur to eliminate sulfur dust; forbids stowage of the fertilizer in a hold adjacent, over, or under a hold in which explosives, flammable liquids, acids, combustible material, or cotton is stowed; recommends against use of paper as dunnage material; prohibits stowage of any other cargo in the same hold; requires a fire watch during vessel loading and unloading where ammonium nitrate cargo is involved; and recommends that production processes be arranged as to permit loading of ammonium nitrate fertilizer in paper bags at temperatures not in excess of 140° F. (present practice permits loading at 160° to 180° F.).

Part I also contains a recommendation that Congress be requested to appropriate funds for the purpose of providing personnel to promote safety in the transportation of dangerous cargoes of all types by vessel. In making this recommendation, the committee points out that a "no man's land" exists between Interstate Commerce Commission and Coast Guard regulations and that no statutory authority or qualified supervisory personnel are available to direct intelligently or to enforce properly regulations for safety.

The ineffectiveness of steam for smothering fires involving oxidizing materials (as attempted aboard the S.S. *Grandcamp* at Texas City and also on the S.S. *Ocean Liberty* at Brest, France*) is well emphasized in the report. It is proposed that a regulation be issued requiring that steam smothering lines terminating in a hold in which ammonium nitrate fertilizer is stowed shall, before the stowage of cargo commences, "have their valves locked in closed position or the line disconnected outside the hold or blanked off or otherwise made inoperative to prevent accidental or purposeful introduction of steam into the hold containing the fertilizer."

Other parts of this Interagency Report deal with "Suggested Procedures to Attain Security of Vessels When in Port and Having on Board or Loading and Unloading a Cargo of Ammonium Nitrate Fertilizer," "Procedure in Event of Fire Involving Ammonium Nitrate Fertilizer in a Cargo Hold of a Vessel"; "Procedure in Event of Fire Involving Ammonium Nitrate Fertilizer Stored in a Warehouse, on Piers, Wharves, and other Waterfront Facilities."

In its closing statements, the committee cites the fact that the transportation of

*See page 116, this QUARTERLY.

dangerous articles is necessary to world economy, health, and other creature comforts and points out the necessity for safe handling procedures for all such materials. The committee notes that while federal authority normally prevails on board vessels, there are conditions under which state or municipal authority may occupy the field. It urges that port authorities and the municipalities in which a port is located accept more responsibility for safeguarding their facilities while also urging that federal employees without other duties be authorized (at an estimate cost of from $500,000 to $1,000,000 per year) to effect day by day enforcement of the safety regulations. Interim safety should be secured, as regards ammonium nitrate fertilizer, by restricting loading and unloading operations to facilities and anchorages designated by the Coast Guard.

Current Port Restrictions.

The Coast Guard on August 8, 1947, prohibited shipments of ammonium nitrate fertilizer in quantities exceeding 500 lbs. without the approval of the District Commander or other officer of the Coast Guard designated by the Commandant. The condition governing approval is quoted directly from the Federal Register (Title 46 — Shipping):

"If the District Commander finds that the proposed facility at which the vessel is to load or unload is in a congested area of the port, he shall withhold the issuance of a permit until the vessel secures the use of a facility in an area so remotely situated from populous centers that in the event of fire or explosion, loss of lives and property may be minimized."

It will be noted that this regulation does not prevent ships loaded with ammonium nitrate fertilizer from entering congested ports and is only applicable in the event the particular commodity is loaded or unloaded. This ban has virtually stopped all exports of the material from U. S. ports except at Theodore, Alabama, and Braithwait, Louisiana, which have the approval of the Coast Guard as shipping points. This limitation has severely curtailed the export of the fertilizer to France, Holland, China, Finland and other countries to which the United States had pledged some 80,000 additional short tons during the current fertilizer year. Increased pressure for shipment of the commodity is resulting from recommendations of the President's Committee on Foreign Aid and the Marshall Plan proposals.

As announced in the daily press, New York City and such foreign ports as Rotterdam and Le Havre have issued blanket prohibitions on handling ammonium nitrate fertilizer along their waterfronts because of the congested conditions. Los Angeles issued tight fire and safety regulations to govern handling of the commodity before the Coast Guard order of August 8 brought about the complete stoppage in congested areas. The Canadian government, according to press reports, permits shipments through certain ports under strict regulations governing stowage and handling. Chief considerations are provision for adequate ventilation in stowage, enforcement of fire prevention measures while loading, and direct handling of the commodity from box car to ship.

The U. S. Army has similarly tightened its regulations for handling the material and now requires: (1) the posting of continuous fire watch on the ship during loading operations; (2) thorough cleaning of the holds prior to the beginning of loading; (3) prohibition against shipment of explosives or sulphur on a vessel carrying nitrate fertilizer; (4) prohibition against carrying any other cargo in the hold in which fertilizer is stowed or any cargo in holds above or below a hold in

which the fertilizer is stowed; (5) prohibition against stowage of acids, flammable liquids, or cotton in holds adjoining those in which fertilizer is stowed.

Transportation by Land.

The Interstate Commerce Commission has amended its regulations for "Transportation of Explosives and Other Dangerous Articles by Freight" (Freight Tariff No. 4)* to include ammonium nitrate fertilizer and to classify it as an oxidizing material. The regulation requires that a yellow label be used and specifies that the maximum quantity in one outside container shipped by rail express is limited to 100 pounds.

The regulations issued by the Commission also require that box cars and motor vehicles have sufficient venting facilities to prevent the development of excessive pressures in the event of fire. To accomplish this, wood box cars or steel cars with sufficient wood floors, roof, or siding are specified on the theory that such construction would provide the necessary venting to prevent the development of dangerous pressures. Previous fire experience in box cars of these types loaded with ammonium nitrate fertilizer is reported to justify the conclusion reached by the I.C.C. Motor vehicles must be of the closed type, but cannot be of all metal construction for similar reasons. The regulations also require that the cars and trucks be clean and free of projections that would injure bags.

Washington Conference.

Major General Philip B. Fleming of the Federal Works Agency, Chairman of the May, 1947, President's Conference on Fire Prevention, called a meeting on September 8 to discuss the hazards of ammonium nitrate. About one hundred people attended. The N.F.P.A. was represented by Mr. Garrett B. James, Sr., Chairman of the N.F.P.A. Committee on Hazardous Chemicals and Explosives.

No transcript of the meeting will be made unless undertaken by a private agency as the meeting was informal, not specifically authorized and no federal funds are available for the purpose.

Chief speakers were: Major General E. S. Hughes, Chief of Ordnance; Col. H. T. Miller, Transportation Corps, War Department; R. O. E. Davis, U. S. Department of Agriculture; Dr. A. C. Fieldner, Department of Interior, Bureau of Mines; Dr. Bernard Lewis, also of the Bureau of Mines; Dr. W. G. McKenna, Bureau of Explosives, American Association of Railroads; Garrett B. James, Sr., N.F.P.A. Committee on Hazardous Chemicals and Explosives; Mathew M. Braidech, National Board of Fire Underwriters; A. H. Nuckolls, Consulting Chemical Engineer (former Chemical Engineer, Underwriters' Laboratories); Col. D. C. Hall, Army-Navy Explosives Safety Board; Commodore H. C. Shepheard, United States Coast Guard; J. Donald Lodge, Railroad Insurance Association; Capt. Harry J. Parker, American Institute of Marine Underwriters; Billings Wilson, American Association of Port Authorities.

All the speakers gave valuable and interesting information on the various phases of the problem as it affects their own sphere of activity. There were no specific conclusions arrived at by the speakers, however, and the only concrete action was to authorize the establishment of a committee of five to further study "the problem of ammonium nitrate combustion when stored aboard ship."

On September 27th the following committee was named by General Fleming: Billings Wilson, American Association of Port Authorities, Chairman; Warren N. Watson, Manufacturing Chemists Association; Dr. R. O. E. Davis, U. S. Department of Agriculture; Commodore H. C. Shepheard, U. S. Coast Guard; and Mathew M. Braidech, National Board of Fire Underwriters.

*Docket 3666, 21 August 1947, 22 September 1947.

Recent Port and Ship Fires and Explosions.

The terrible loss of life and property at Texas City on April 16-17, 1947* illustrated in a tragic manner the vulnerability of ports to ship fires and explosions.

In this article, we will report on a series of other major ship-port fires which have occurred since Texas City against a background view of the general problem of protection of waterfront properties from this type of fire and explosion damage. The examples used include the S.S. *Markay* explosion and fire in Los Angeles Harbor on June 22; the S.S. *Ocean Victory* fire and explosion at Brest, France, on July 28; the S.S. *Mahia* fire and explosion at Melbourne, Australia, on August 7; and the Port Alberni, British Columbia, wharf and freighter fire of August 25.

It has long been recognized that waterfront properties, particularly piers and wharves, are inherently exposed to fires and explosions on vessels using the port facilities. The seriousness of these exposure conditions depends upon the following basic factors:

(1) Construction, protection and inherent hazards of the physical waterfront properties.

(2) Fire safety of the vessels from a design viewpoint.

(3) Mobility of the vessels during docking.

(4) Cargo handling and stowage procedures.

Piers and Wharves.

Standards for the construction and protection of piers and wharves were adopted by the N.F.P.A. in 1935 and are published in the National Fire Codes, Vol. III, under the title "Recommended Good Practice for the Construction and Protection of Piers and Wharves." These standards have also been adopted by the National Board of Fire Underwriters and the American Association of Port Authorities. These standards, however, have been more honored in the breach than in the observance, in the absence of legal requirements for pier construction.

With regard to the fire record of substandard piers and wharfs, the large loss fires published in the N.F.P.A. QUARTERLY since January, 1945, provide twelve examples of note:

Date of Fire	Place	Estimated Loss	Quarterly
Jan. 17, 1945	Norfolk, Va.	$900,000	Jan. 1946
July 17, 1945	Port Edward, Ont.	3,000,000	Oct. 1945
Aug. 30, 1945	Portland, Oregon	3,000,000	Oct. 1945
Dec. 5, 1945	Long Beach, Calif.	1,000,000	Jan. 1946
Jan. 25, 1946	Staten Island, N. Y.	712,000	Jan. 1947
July 14, 1946	Pictou, Nova Scotia	836,000	Oct. 1946
Sept. 18, 1946	Galveston, Texas	540,000	Jan. 1947
Sept. 29, 1946	Bucksport, Maine	400,000	Jan. 1947
Oct. 10, 1946	Charlottetown, P.E.I.	250,000	Jan. 1947
Nov. 10, 1946	Chalmette, La.	1,000,000	Jan. 1947
Jan. 8, 1947	Weehawken, N. J.	6,000,000	Apr. 1947
Sept. 28, 1947	New York, N. Y.	3,500,000	Oct. 1947
	Total	$21,138,000	

The exceedingly high losses per fire indicated above (averaging $1,750,000) are typical, rather than the exception, for this type of structure. The Texas City disaster is not included in this list, as it is not

*QUARTERLY, July 1947.

classified as involving substandard piers; if it were, the average loss per fire would be nearly $7,000,000.

Vessel Fire Safety.

The fire safety of a vessel, like any type of structure, can be measured by analyzing its inherent design safeguards and hazards. Chief considerations are subdivision of areas by fire-resisting bulkheads to the weather decks to confine spread, dampers in all ventilation ducts which operate automatically or may be closed from the bridge, enclosure of stairwells or other vertical openings, elimination of combustible trim and dunnage, automatic fire detection equipment (smoke or flame), and fire extinguishing systems of proven ability. Steam smothering systems for cargo fires have been proven ineffective for extinguishment of fires in holds containing ordinary combustible materials (Reference: Phobus tests conducted by the U. S. Coast Guard during 1946.[1] For oxidizing materials, these steam systems are known to intensify an existing fire.[2]

Mobility of Ships in Ports.

Mobility of vessels during their docking is a phase of "in-port seamanship." In an article in the July 1947 issue of *The Log*,[3] Rear Admiral F. D. Higbee, USCG (Ret.), Warden of the Port of Los Angeles, places emphasis on this subject most effectively by saying:

"Equally important may be 'in-port' seamanship, which involves safe moorage and readiness to get underway whenever the ship is jeopardized by surrounding conditions or when the ship itself may become a menace to the port and public safety. It is sometimes lubberly for a ship to get caught too close off a lee shore, and it is sometimes equally dangerous to the ship to be caught docked in a dead-end channel or slip, stern seaward, in a position from which the ship cannot be extricated without towboat assistance. This may be found more so if the ship has disabled its main engines and is docked a distance from tugs. . . . A prudent seaman will, however laden, point his ship seaward from a congested corner, having regard to the jeopardy of activities close at hand."

The fact that many terminals and docking facilities are arranged to handle freight with the ship bow-in is recognized, but such arrangements can be altered to improve safety, and Admiral Higbee states that where this has been done it has been preferred over the previous method.

Cargo Handling and Stowage.

The handling and stowage procedures followed by shippers and labor are naturally the key to safe operation in the majority of cases. With our waterfront labor controlled largely by strong union organizations, the responsibilities must be shared by both groups. This is particularly true because of the "no-man's land" which exists between the regulations of the Interstate Commerce Commission and those of the U. S. Coast Guard. Commodities discharged from land carriers are not subject to federal regulations until they are placed aboard vessels. It is during this interval that the greatest hazard exists, due particularly to the handling and storage procedures in common practice. Municipal authorities are normally not pursuing this phase of fire prevention activity with sufficient vigor, despite the fact that much of the property involved is publicly owned.

[1] See N.F.P.A. Proceedings, 51st Annual Meeting, May 1947, page 131.

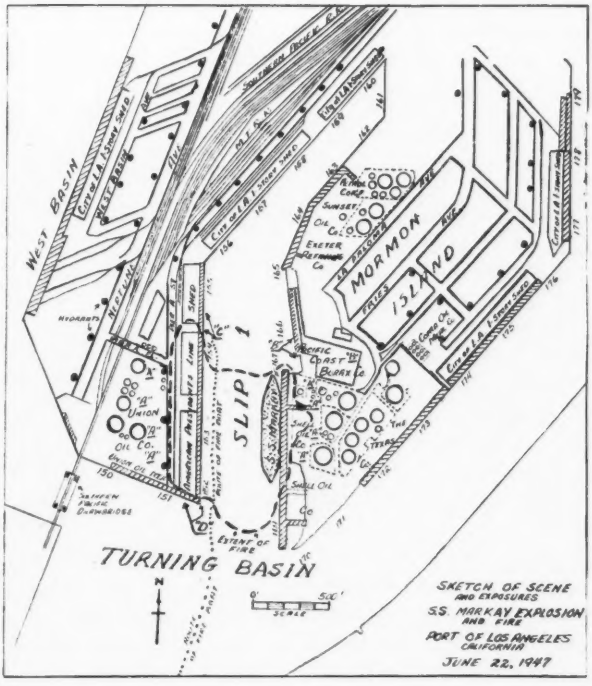
[2] See article Ammonium Nitrate, Interim Report, page 104.

[3] Published by Miller Freeman Publications, 121 Second St., San Francisco 5, Calif.

Acme.

General view of *Markay* fire in Los Angeles harbor, showing both sides of 600 ft. slip involved and serious exposure factors. Gasoline thrown on water spread flames to opposite shore immediately following explosion.

The Markay Explosion, Los Angeles Harbor.



General view of *Markay* fire in Los Angeles harbor, showing both sides of 600 ft. slip involved and serious exposure factors. Gasoline thrown on water spread flames to opposite shore immediately following explosion.

The lessons learned by members of the Los Angeles Fire and Harbor Departments by virtue of their personal inspection of the Texas City disaster, stood them well two months later when the 10,000-ton tanker S.S. *Markay* exploded in Los Angeles Harbor at 2:05 A.M. June 22, 1947. Caused by ignition of vapors given off during the loading of butane-blended gasoline, the explosion had the immediate effect of involving the congested sections of the industrialized area surrounding Mormon Island (see location sketch). Only by effective implementation of pre-arranged disaster plans was the fire controlled successfully.

Loading of the Markay.

Immediately after the tanker docked at 1:00 P.M. on June 21st at Berth 167 of the Shell Oil Terminal on Mormon Island, the Master of the vessel was advised that they were going to load the butane-blended gasoline in No. 4, 5 and 6 tanks. This mixture consisted of 31 per cent butane and 69 per cent natural gasoline and had a vapor pressure of 20.3 lb. (Reid). Unusual precautions were ordered to preclude any danger of fire, including prohibiting smoking during loading, prohibiting any cooking in the galley, closing and dogging of all air ports, closing of all watertight doors and the issuance of orders that they remain closed, the trim-

ming of all ventilators on the afterhouse away from the loading deck, and the closure of engine room skylights.

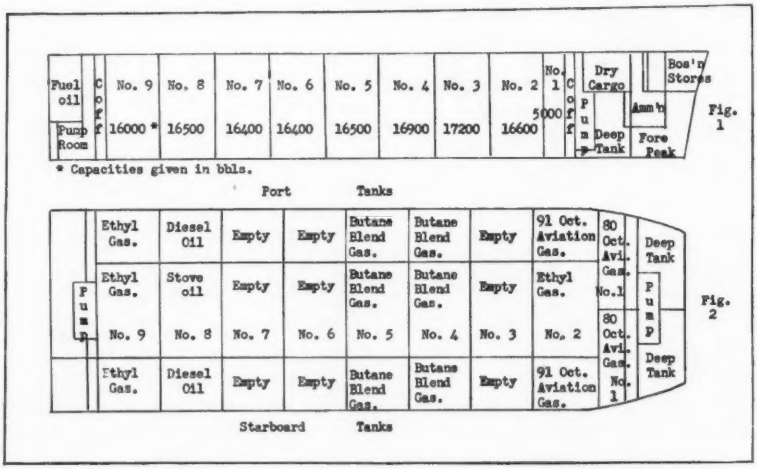
At 3:45 P.M., loading operations were started and the following schedule indicates the progress made up to the time of the blast:

Product	Start	Finish	Bbls. Loaded
80 octane aviation gasoline	3:45 P.M.	6:00 P.M.	4,900
91 octane aviation gasoline	3:55 P.M.	7:25 P.M.	6,800
Diesel fuel	4:00 P.M.	6:40 P.M.	7,500
Butane-blended gasoline	4:25 P.M.		30,000
Stove oil	7:15 P.M.	11:00 P.M.	8,900
Premium gasoline (red ethyl)	8:30 P.M.		19,000

The distribution of the various products in the tanks of the vessel is indicated on the sketch below, which shows the fuel capacities and loads at the time the explosion occurred. The butane-blended gasoline was delivered to the *Markay* from the Shell Oil Refinery about 5 miles distant at a rate of approximately 3,000 barrels per hour.

Accumulation of Vapors.

The crew on board the vessel at the time of the explosion was under the command of the Third Mate (serving double shifts for the Second Mate), and testimony from those surviving indicates that extremely heavy vapors were present on the main deck in the vicinity of No. 4 tank's loading valves starting about 11:00 P.M. The condition was so bad that the Chief Mate (off duty) was forced to leave his quarters amidships soon afterwards, an action which subsequently saved his life. The gaseous condition extended all along the starboard side of the forward main deck and crewmen were forced to seek refuge from the fumes in the shelter deck space while taking turns closing the No. 4 valves and relaying signals for opening the loading valves on the No. 5 tank. The persistency of the vapor condition is attributed in part to the calm (wind 2 miles per hour, westerly) and to the high humidity (84 per cent), which restricted



Diagrammatic sketch of the *Markay*, showing fuel capacities (Fig. 1) and loads (Fig. 2) on June 22, 1947.

their dissipation by natural means. The source of the vapors was obviously from the ullage holes, plugs not having been inserted in them, since regulations do not require such action except when loading liquefied gases, and these holes are used for gauging (no separate gauging devices being installed).

The Explosion.

The opening and closing of the shelter deck space doorways (against orders but understandable under the conditions) permitted vapors to accumulate in this and the midship quarters. The core of the explosion, which occurred at 2:05 A.M., was undoubtedly just aft or in the midship house. This conclusion is indicated by the fact that the after bulkhead of this space was blown outward, landing across the loading manifold atop No. 6 tank and by the fact that the upper decks over this part were sagged down over the area from which the bulkhead had been torn.

The Cause.

The exact ignition source is not definitely known and probably never will be determined with accuracy because of the heavy damages incurred to the vessel and the fact that those on the scene in a position to know were killed. Possibilities include the speed regulators on electric fans in the Officers' quarters and radio room, the nonexplosion-proof electric light switches in the officers' quarters, wires believed left exposed following the charging of a spare battery in the radio room, or defective electrical equipment (believed of the explosion-proof type) located on the shelter deck. In any case, despite the heavy vapor conditions no tests were known to be made of the explosive concentrations which undoubtedly existed in many parts of the vessel, and loading operations continued even though crew members were exposed to vapors which could not have been other than injurious to their health.

The Result of the Explosion.

Eight crew members were killed and three wharfingers of the Shell Oil Company were fatally injured by the blast, the majority being hurled overboard. Twelve other crew members were injured and nine of these hospitalized. Most of those who were on board the *Markay* and escaped went down the stern line to safety. Only one man, the operator of an incoming barge, is known to have observed the initial fire and explosion. He stated to the Coast Guard Board of Inquiry that the origin was on the port side of the main deck near No. 5 tank (being loaded) just abaft the midship house. He also observed that burning gasoline immediately spurted out of the vessel and within three minutes the entire width of Slip No. 1 was afire. Flames almost immediately ignited the Shell Terminal dock near Berth 167, the pump house and laboratory, and seriously exposed the Pacific Coast Borax plant located adjacent to Berth 166 and built on exposed wood piling.

Across the 600 ft. wide slip, Berths 153 and 154 became involved in fire along their 1,200 ft. length within the first few minutes. These flames communicated to the two one-story, steel frame and corrugated iron, sprinklered buildings (each 600 ft. long) used as pier warehouses by the American President Lines. Fortunately these warehouses were practically empty following the earlier evening departure of a cargo vessel from this berth. The intense heat developed from the burning gasoline and oil-soaked wood piling under the warehouses resulted, however, in the buckling of the unprotected steel structural members. The automatic sprinkler

Los Angeles Fire Dept.

Photo shows heavy damage to the *Markay* and adjoining pier. Note fuel tank which was seriously exposed and Pacific Coast Borax plant in right background (built on wood piling).

systems in the warehouses proper were so heavily damaged by the explosion that they were ineffective. There were no sprinklers for the open substructure area and the fire was only stopped in the center of berth 154 where a transverse bulkhead aided firemen operating from a fire boat which made a daring run from the Turning Basin (see page 111).

Fire Fighting.

Personnel of the first unit of the fire department arrived at the scene (from a station one-half mile away) before the alarm was given, having felt the concussion and seen the flames. Multiple alarms were immediately sounded. Chief Engineer John H. Alderson directed operations and mobilized 19 engine companies, 3 truck companies, 3 foam carriers, 3 fire boats (plus Navy and Coast Guard tugs with monitor fire nozzles), 2 boat tenders, and 4 rescue, salvage and utility companies.

Immediate action was taken to protect the seriously exposed oil tank farms ("A" on sketch), the Pacific Coast Borax plant ("B"), the connecting wharves and sheds of the American President Lines ("C"), and the Union Oil docks ("D").

The use and value of radio at a fire of this magnitude were demonstrated most effectively in controlling the movement of fire companies and fire boats and directing operations on both sides of the slip simultaneously.

Port Disaster Crews.

The Port Disaster Section personnel were simultaneously removing all endangered ships from the Harbor, manned by crew members and longshoremen who were mobilized to act for absentee sailors. In addition, pilots went automatically to their stations, all harbor tow boats were manned and aided in evacuation work, water taxis hovered to pick up possible survivors, police threw blockades across all access roads at a safe distance, workers were provided with distinctive arm bands, and railroad switch engines were engaged in moving freight cars from the area.

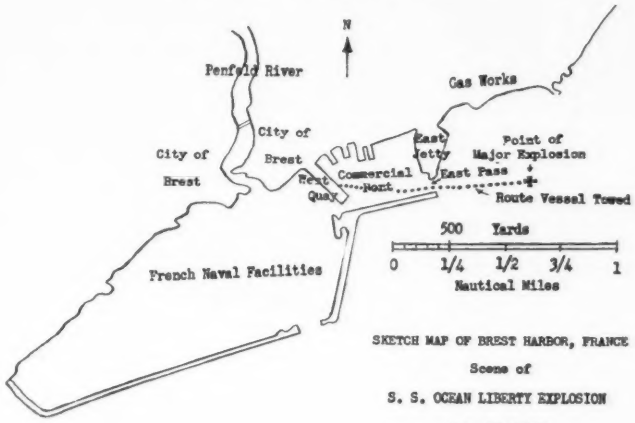
The Disaster Plan was effective because all the agencies who would be concerned in a port emergency were participants.

Key men from shipping, railroad, oil company, lumber, and fishery interests were represented, as well as waterfront employees, the Navy, Coast Guard, fire and police departments. Essential tasks were prescribed in advance.

Losses.

The loss of life and injuries sustained have been previously reported in this article. The property damage is estimated at approximately $5,000,000, including the value of the *Markay,* its cargo, and damage to the wharves, warehouses, and adjacent property. That it might have been many times worse without the effective fire fighting and disaster planning is a foregone conclusion. This city, its fire department and its Port Warden are to be commended.

The Brest Fire and Explosion.



SKETCH MAP OF BREST HARBOR, FRANCE
Scene of
S. S. OCEAN LIBERTY EXPLOSION
July 28, 1947

What appeared as an isolated catastrophe in April was shown to be a continuing threat by a duplicate disaster in July. While many experts were attempting to label as a phenomenon the vicious explosive force of the ammonium nitrate fertilizer decomposition under fire conditions at Texas City, a repeat performance was given at Brest, France, on July 28, 1947, which established the true dangers of the compound. In the latter disaster, 21 persons were killed, 100 persons were seriously injured, buildings over a three-mile radius were heavily damaged and the vessel with its cargo was totally destroyed.

There were elements of striking similarity between the explosions of the S.S. *Grandcamp* at Texas City and the S.S. *Ocean Liberty* at Brest, which deserve the immediate attention of the reader:

1. Both ships were first attacked by fire.
2. Both initial fires could have been caused by smoking or any similar common cause of fire. It is not believed that fire in either case originated from any special hazard which might be laid to the cargo.
3. Both causes were essentially immaterial with regard to the end results, any source of fire being capable of producing like results.
4. Both results were explosive blasts of high magnitude originating in the lower cargo holds of the vessels affected.
5. Both vessels were Liberty ships of 7000 odd gross tonnage loaded with a mixed cargo.

6. Both cargoes contained many tons of ammonium nitrate fertilizer packed in 100 lb. paper bags and stowed within the confined spaces of the lower holds of the ships.

7. Both stowage areas were subject to increasing heat due to the involvement of combustible materials by fire.

8. Both fires were first attacked by the steam smothering systems.

9. Both steam systems failed to accomplish extinguishment, increased the intensity of the existing fires and therefore sped the chemical decomposition of the nitrate compounds.

10. Both fires might have been extinguished if prompt action had been taken to apply large amounts of water on the burning material.

There were also important aspects of the Brest disaster which were definitely different from its predecessor. In the *Ocean Victory* case:

1. The ammonium nitrate fertilizer was not being handled (loaded or unloaded) at the time of the explosion. (Texas City's first blast occurred during loading operations.)

2. The fire department was immediately notified and arrived within 10 minutes of the discovery. (Texas City featured a delayed alarm which delayed response.)

3. The vessel was towed from the immediate proximity of the congested port area when it was determined that fire control was problematical. (At Texas City, neither the *Grandcamp* nor the *High Flyer* were moved from their dockside positions.)

4. The major explosion occurred 5 hours after fire was first discovered and was preceded by a lesser warning blast within 25 minutes. At Texas City, the *Grandcamp* exploded with violence within one hour following discovery and the *High Flyer* after 7 hours, and there were no preliminary blasts.

Chronological Account.

The S.S. *Ocean Liberty* was operated by the Bendixen Company of Norway and had sailed from New York for Antwerp on July 11, 1947. The ship was diverted to Brest because of a stevedore strike at Antwerp and arrived in the former port on July 23rd. Unloading operations were begun the following afternoon at a dock in the West Quay.

The cargo of ammonium nitrate fertilizer was in lower holds No. 1, No. 3 and No. 5 in quantities of 739 tons, 1,381 tons and 1,189 tons respectively (total 3,309 tons). No other cargo was stowed in the lower holds with the fertilizer compound. As none of the fertilizer or cargo stowed in tween decks of holds No. 1, No. 3 or No. 5 were to be discharged at Brest, the deck hatches to the holds were not uncovered.

On July 28th unloading work was in progress for commodities in holds No. 2 and No. 4 and for the deck cargo around the No. 3 hatch. It was 12:35 P.M. when thick yellow smoke was first observed from the ventilator of No. 3 hold.

Fire Fighting.

The steam smothering system was immediately turned on and the local fire brigade and those from the French Naval Base at Brest arrived within 10 minutes of the initial discovery of fire.

Firemen covered the ventilators with tarpaulins (spraying them with water to avoid ignition) following the misconception that the steam smothering system would be effective.

As the smoke was noticed to increase instead of diminish, a few hatch boards were removed and water was poured into the hold from hose lines on the deck. It is doubtful that any substantial amount of this water reached the lower hold as the tween-deck hatch was undoubtedly covered. The only flames observed up to this time issued from the ventilators of No. 3 hold, indicating an advanced fire in the nitrate. Heat and smoke increased rapidly and became so intense that firemen were forced to withdraw from the vessel.

At about 1:00 P.M., the Master ordered the engines prepared to take the ship to sea. At about the same time, however, a light explosion took place, which blasted the remaining hatch boards from No. 3 hold, threw tween-deck cargo into the air for a few yards and caused flames to shoot out of the hold. The order was immedi-

ately given to abandon ship and plans were then made to tow the vessel out of the inner harbor.

Movement of the Vessel.

The authorities on the scene (the Port Director, the French Naval Commander at Brest, and the Director of the local Agency for the Steamship Company), ordered tugs to tow the vessel out the East Pass (see sketch) from its berth on the West Quay. It was anticipated that the vessel would ground shortly after leaving the Pass because of the draft of the vessel and the depth of the water in this area. The necessity to remove the burning ship from the commercial port and the populous city area was the primary consideration, however, and the towing commenced at 1:45 P.M. (about an hour and ten minutes after the fire was discovered).

During the movement, the fire was observed to increase. By the time the vessel cleared the East Pass, No. 2 hold was afire. There was no fertilizer in this space, but flammable liquids (including petroleum products) and highly combustible materials (including corn meal) in the cargo involved produced a hot fire. For a short period after the vessel was grounded, the fire seemed to temporarily lessen and firemen returned aboard the vessel and attempted to secure extinguishment, with a French Navy fireboat also assisting. No. 1 hold became involved soon thereafter, including the 739 tons of fertilizer in the lower hold. The heat and flames mounted rapidly, forcing a second abandonment of the vessel by all aboard, including fire fighters.

During the next several hours, a variety of attempts were made to flood the fire by piercing the hull of the grounded ship. A French Navy gunboat fired nonexplosive shells into the burning holds, attempting to hit the water line. The attempts were unsuccessful and those shells which pierced the hull above the waterline allowed freer air circulation, which increased the intensity of the fires. At about 5:00 P.M., a charge of dynamite was attached to a buoy and set off about a yard from No. 1 hold with the intent of blowing a hole in the side of the vessel. This was also unsuccessful. A second charge was being attached directly to the hull when the ammonium nitrate fertilizer exploded (5:38 P.M.).

Results of the Blast.

The S.S. *Ocean Liberty* was a complete structural loss as the result of the explosion. Only the stern (beginning at the forward part of hold No. 5) remained intact.

Twenty-one persons in the city of Brest were killed, and approximately one hundred received serious injuries from the blast damage effects and direct concussion forces, despite the fact that the vessel was over 800 yards (almost a half-mile) from the nearest shore installations when the explosion occurred. No one was on board when the nitrate cargo exploded.

Physical damages to the city may be divided into two categories. The area surrounding the commercial Port at water level consisted of industrial plants and warehouse facilities. Here the structural damage was most severe. A group of newly erected warehouses of combustible construction located on the East Jetty (800 yds. from the explosion) were demolished and burned. A large overhead crane for loading and handling heavy machinery was toppled. A chemical plant (900 yds. distant) was destroyed by fire following blast damages. The gas works was badly damaged.

Property destruction in the business and residential districts (about 300 ft. eleva-

tion) was not so heavy. One group of temporary wood buildings about a mile from the explosion were set afire. Interior walls of many other buildings were blown down by the blast and almost all window panes in the city were broken. The serious damage was roughly within a 3-mile radius, but minor damages were incurred by structures as far as ten miles away and the blast was felt in Morlaix, France, 40 miles from Brest. Total preliminary estimates of shore damages ranged from $3,000,000 to $5,000,000. The light, combustible construction prevalent in the city as a result of postwar efforts to make the city habitable (following bombing attacks by Allied planes during 1944) had a distinct influence on the destruction sustained by the city. Details on fire fighting activity on the shore following the explosion are lacking as this report is prepared.

The Melbourne Fire and Explosion.

Perhaps this fire and explosion occurred to remind us all that ammonium nitrate fertilizer was not the only dangerous commodity being handled along the waterfronts of the world. It was another expensive lesson which cost ten lives and caused damages estimated at $500,000 to cargo alone.

Sodium chlorate was the material directly responsible for the original fire and explosion aboard the S.S. *Mahia,* a 10,000-ton freighter of British registry. The hazardous properties of this oxidizing agent are generally better known to the fire protection fraternity than was ammonium nitrate fertilizer at the time of the Texas City disaster. A colorless, odorless, crystalline material, it is commonly used in the leather tanning and finishing industry, in matches and in making certain types of explosives. U. S. Coast Guard regulations* require a yellow label for shipments aboard marine vessels and specify that stowage must be on deck under cover or tween decks readily accessible.

The *Mahia* arrived in Melbourne on August 6 and tied up at the Victoria Docks to unload its general cargo, which included about 60 tons of the sodium chlorate in iron drums with paper linings. This material had been loaded at Montreal, Canada, and had been carried on the deck adjacent to No. 4 and No. 5 hatches during the voyage of about 10 weeks.

Unloading Operations.

Unloading originally commenced at nine o'clock on the evening of the ship's arrival, but operations were promptly stopped as rules promulgated by the Melbourne Harbor Trust (port operators) prohibit the unloading of sodium chlorate at night and specified that delivery must be taken from the wharf immediately following discharge. About 9:00 A.M. on August 7th, the discharge of the cargo was authorized and about one-third of the sodium chlorate had been unloaded when fire broke out (11:25 A.M.) aboard the ship in the immediate vicinity of the chlorate still aboard.

While the exact cause of the fire is not known, it is thought that the iron containers of sodium chlorate had deteriorated during the sea voyage, permitting spillage of the contents. Perhaps a friction spark, developed by the scraping of drums during handling, provided the ignition source. Within the first few minutes of

*Explosives or Other Dangerous Articles on Board Vessels.

the fire, four minor explosions occurred in containers subject to the deck fire, despite the efforts of ship personnel to control the flames by hand extinguishers and hose lines stretched from the adjoining dock's cargo sheds.

Spread and Fire Fighting.

At 11:27 A.M., the alarm was received by the Metropolitan Fire Brigade. A minute later, the officer in charge of the first apparatus en route reported by radio that there was considerable smoke, and this information resulted in the dispatch of additional equipment and men. At 11:32, a call for further assistance was placed and more units responded. By this time, the explosions had scattered burning bits of sodium chlorate over the deck, the adjoining dock and down into the holds where the hatches had been opened. No. 4 and No. 5 holds were heavily involved before the fire department could marshal its strength, and isolated fires had been started on the roofs of adjoining buildings up to 150 yards away from the ship. These structural fires seriously exposed the property of the West Melbourne Gas Works, which had three large outdoor gas holders.

Prompt action by the Brigade resulted in immediate control of the dock and structural fires, and by 11:45 all efforts were concentrated on checking the flames on the *Mahia*. Fifteen hose lines (operated from the wharf) delivered about 4,000 gallons of water per minute for an hour before it was judged safe to go to below deck areas in No. 4 and No. 5 holds. Firemen wearing self-contained breathing apparatus entered these areas and discovered four bodies at the foot of an escape hatch on the shelter deck. This was the first indication that men had been trapped in the holds by the fast spreading fire which resulted from the deck explosions. The lower holds could not be reached even at this time because of the continuing intensity of the fire in these inaccessible regions.

By about 2:15 P.M., substantial progress had been made in fire suppression, but the large quantities of water poured into the vessel were causing a 15 degree list, which placed such a heavy strain on mooring cables that some parted. At 2:25 P.M., the decision was made to temporarily abandon fire fighting until holes could be cut in the lower holds to flood these portions and prevent capsize. While this action was being taken, the fire increased markedly and it was 4:00 P.M. before control could again be established. Final extinguishment was not secured until 6:00 P.M. and the vessel slowly reversed her list, heeled toward the wharf and settled by the stern.

On the following day, salvage operations were started and the *Mahia* was refloated within 48 hours. Six additional bodies were discovered to bring the total casualties to ten. Dunnage contaminated by sodium chlorate was destroyed and the vessel washed down.

Conclusions.

Perhaps the most significant items are that the cargo was recognized as hazardous, that precautions had been issued to govern its safe handling, and that, despite these facts, a fire of serious proportions developed which threatened the entire port. The fire itself was well handled by the organized fire fighters considering the circumstances which existed at the time of their arrival. (The Brigade responded to the alarm of fire at the request of Harbor Trust authorities, although the former has no official responsibility for the port facilities.) The heavy cargo loss and the extensive damage to the vessel resulted because the fire in the holds was inaccessible to direct attack by hose streams.

The Port Alberni Wharf and Freighter Fire.

Remains of wood wharf at Port Alberni following disastrous fire. Dry combustible construction, lack of fire stops and absence of automatic protection doomed decking, but creosoted piling was only charred and can be salvaged for new construction.

All of the previous fires and explosions reported in this article originated on vessels and caused serious damage or constituted a major threat to the exposed waterfront properties. This fire at Port Alberni, British Columbia, illustrates the "vice versa" effect — how a fire originating on a pier can involve a vessel.

Construction and Materials Handled.

The wharf at this lumber and plywood shipping center on Vancouver Island was 1,000 feet long and extended obliquely from shore to deep water. Constructed of creosoted timber piling decked with 4 by 12-inch untreated planks, the wharf had neither fire stopping beneath the decking nor any form of installed fire protection facilities. A ramp of similar construction, 100 ft. long, jutted out from the shore at right angles and connected with the wharf proper at midpoint. A large-area, unsprinklered, frame warehouse was located on the shore end of the ramp and this building contained 600 tons of plywood on August 25th at 9:00 A.M. when workmen arrived to load the material aboard the 10,000-ton freighter S.S. *Sampep,* which was docked at the wharf.

The plywood, bonded by phenolic-resin glue, was wrapped in 300 lb. bundles, with the exterior protected by heavy waxed paper. About 300 tons had been loaded on the ship by 5:00 P.M. when operations ceased for the night. The warehouse was locked and the property left unguarded for the night.

Discovery of Fire and Early Spread.

About an hour later, a fisherman noticed smoke issuing from the warehouse. His wife called the volunteer fire department while he tried unsuccessfully to get help from the crew of the *Sampep.* The alarm was received by fire headquarters at 6:15 P.M., but by the time equipment could be assembled, the fire had

spread through the roof of the light structure and had reached the substructure. Aid was requested and received from Alberni, but the total fire equipment available consisted only of three pumpers, a trailer pump and a fire boat.

The spread of fire along the ramp and wharf was such that it became apparent that the property was doomed. Land fire equipment accordingly took up positions to protect exposed properties, which included a lumber company and bulk oil storage tanks, while the fire boat and volunteers concentrated on futile attempts to hold the fire from the freighter. A fifteen-mile per hour wind drove the flames toward the ship and to some 1,500,000 board feet of lumber stored on the dock awaiting loading. The position of the ship blocked attempts by the fire boat to reach the wharf sections most directly threatening the ship.

Spread to the Ship.

The combustible cargo on the deck of the vessel (lumber and plywood) rapidly became involved and the entire superstructure was soon engulfed in flames. The ship's captain reportedly gave orders to the crew to abandon ship and several men jumped overboard and swam to shore or were picked up by boats.

The *Sampep* was without steam and was tied to the wharf fore and aft with her starboard anchor down, contrary to port regulations. During the early stages of the fire there was no attempt to move the vessel. Chief Venables finally secured the services of a local welder, who cut through the anchor chain, and tugs finally towed the burning vessel from the wharf. By this time, the fire had entered No. 2 hold, but this blaze and the deck fires were finally controlled by fire fighters.

Stack of plywood on pier at Port Alberni not destroyed except for exterior wrapping (waxed paper).

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Capital Fabricators Fire.

Production of badly needed prefabricated houses was halted indefinitely at the Capital Fabricators, Inc., Austin, Texas, on July 17, when flames destroyed all but a few outbuildings on their 20-acre premises. The plant built in 1945 was one of the largest of its type in the United States, having a capacity of 300 houses per month. However, several features, either overlooked or ignored when this plant was still in the planning stage, doomed it to early destruction by fire. The fire of July 17, the first on record at the premises, was a spectacular show for 5000 spectators, but is of interest to N.F.P.A. members because of the roles played by combustible building construction and inadequate public and private fire protection.

Two large one-story structures dominated the eighteen buildings that made up this manufacturing plant. The warehouse, smaller of the two, comprised one large area of 30,679 sq. ft., with no fire divisions. Wall construction was substantially of wood throughout. A rest room in one corner was accessible 24 hours a day from outdoors as well as from within the structure. Since fire was first discovered inside the warehouse near the rest room, it is possible that a trespasser may have entered through this room and set the fire either accidentally or intentionally. At the time, the building was loaded with stacked wall and roof sections of future houses. The larger mill building, also one story high and covering about 1½ acres, was forty feet away. Walls in this case were of corrugated aluminum on wood frame, but here again no serious attempt was made to subdivide the large area housing many hazardous operations. The wooden partitions erected to segregate the paint spray area and the machine shop offered little if any protection against the spread of fire in these areas. Numerous electric motor-driven planers, saws, presses and other equipment common to woodworkers were located in the building. Most of the machinery was provided with a blower system connected to two cyclone dust collectors on the roof. These discharged into a refuse burner located six feet from the mill building. The value of fire-resistive construction is clearly demonstrated by this refuse burner (see accompanying photograph), the only structure in the fire area to survive the flames. Scattered throughout the rest of the 20-acre factory site were sixteen smaller one-story wooden buildings and several huge piles of lumber and stacks of window frames and doors. Congestion was such that the entire area was subject to a single fire.

A vast area of congested combustible construction interspersed with lumber piles should have been entrusted to none but the best in fire protection. Austin has a well-equipped and efficient fire department. The Capital factory was located at the farthest outskirts of the city, however, 3½ miles from the nearest fire station. Fire alarm circuits had not as yet been extended to this outlying district. A separate water system serving 300 domestic users as well as several manufacturers consisted of a 6-inch main supplied by a 50,000-gal. tank elevated 100 ft. The

NOTE: This report is based upon data furnished by the General Adjustment Bureau, Inc., Austin, Texas, and by the Fire Prevention and Engineering Bureau of Texas.

Acme.

Combustible construction and inadequate public and private fire protection contributed to the destruction of the buildings of Capital Fabricators, Inc., July 17. The factory had a capacity of 300 prefabricated houses per month.

tank in turn received its water from the Austin water system through a mile-long 6-inch main in which a 4-inch meter had been installed. The one hydrant available in the vicinity of the Capital plant was 500 ft. from the mill building.

Private protection was equally lacking. The absolute minimum, a complete automatic sprinkler system with an adequate water supply, had been omitted. The owners had recently recognized this deficiency and contracted for sprinkler installation. A few water barrels with buckets and hand extinguishers had been placed at strategic locations throughout the buildings. A watchman patrolled the premises after hours.

The odor of smoke called the attention of the watchman to fire in the warehouse at 7:05 P.M., ten minutes after he had passed the building. Rushing into the warehouse, he found one end of the structure in flames. The watchman realized at once that the fire was beyond control of the meagre first aid equipment at his disposal, and telephoned the Austin fire department. A brisk wind in the meantime was whipping the flames through the heavily laden warehouse and sparks had ignited the mill and lumber piles when the first apparatus arrived. Two subsequent alarms transmitted by the fire chief brought the total equipment at the scene to four engines and three service trucks. One engine connected to the only nearby hydrant and supplied two 2½-inch lines. Two other 2½-inch lines from a hydrant a considerable distance from the fire were replaced by 1½-inch lines because of weak water pressure. No other streams could

be brought into play because of the long lines required and the inadequate water supply which continually interfered with effective use of the four streams already in use.

The roof of the mill soon fell in and within an hour the refuse burner and one or two outlying buildings to leeward were the only structures standing. Firemen continued to wet down burning lumber piles and stacks of window frames and doors for several hours.

This fire was one of the largest in Austin's history and insurance officials were quoted in the newspapers as being of the opinion that as a result the city's insurance rates would unquestionably be increased. The total loss of $827,096, of which about one-third was covered by insurance, was divided as follows: $207,242 on buildings, $497,951 on contents and $121,903 on lumber stored in the open.

Lexington, Nebraska, Fire.

The group fire at Lexington, Nebraska, August 20, illustrates the vital part played by telephone operators in the efficient operation of fire departments in small communities unprotected by a fire alarm system.

Rosenberg Co.'s furniture store and two smaller stores occupied an unsprinklered two-story brick, wood-joisted building at a street intersection in the business district of the town. The Rosenberg Lumber Co. premises, adjoining the furniture store in the rear, contained two large lumber sheds, a carpenter shop, lumber piles and fifteen cylinders of bottled gas stored on a wooden platform. No watchman or automatic fire detection equipment was provided for the store or lumber yard.

A woman looking from her apartment at 11:45 P.M. saw fire in the show window of Rosenberg Co.'s furniture store across the street. She immediately notified the telephone operator, who in turn sounded the fire siren, gave the chief the location of the fire, and notified the store manager at his home.

Dawson County Herald.

Ruins of a Lexington, Neb., business block destroyed by fire that started in a lumber yard in the rear.

A 500-gallon pumper was the first to reach the store. Two 2½-inch lines equipped with combination fog and straight stream nozzles were taken in through the front door where firemen were confronted with six separate small fires. Except for the show window fire, which involved a mattress, the burning material was either paper or rags. The fires were unquestionably incendiary, set for the purpose of concealing evidence of robbery. All fires were quickly extinguished, using a hand extinguisher on one and fog on the others.

The fire chief in the meantime, having been told that the fire was "at Rosenberg's," responded directly to the lumber yard and discovered a blaze in the carpenter shop (also believed to be incendiary). He went to a telephone in the

This report is based on data from the Nebraska Inspection Bureau and from Fire Chief Leon Trautman.

Dawson County Herald.

Fire confined to lumber yard property when this picture was taken eventually destroyed five nearby stores in Lexington, Neb.

Veterans of Foreign Wars building nearby and sent in another alarm, which brought the second Lexington pumper. Lines from the first pumper had been taken around to the lumber yard and were in operation when the second pumper arrived and supplied an additional 2½-inch line. These lines were not sufficient to control a fire involving large quantities of combustible material and flames soon spread to other sheds and lumber in the yard. At midnight, the chief instructed the telephone operator to call surrounding towns for aid and a few minutes later asked that she call North Platte and the Kearney Air Base, 36 and 60 miles away, respectively. By 12:20 A.M., help from the nearer surrounding towns began to arrive and by 12:45 A.M., crews from all but the two most distant localities were at the scene. Five towns and the air base furnished a total of six pumpers and 67 men. Since there were no free hydrants when the last pumper arrived, it was obliged to connect to a 2-inch outlet in the fire department building two blocks away.

With the assistance of these mutual aid companies, the Lexington fire department was confining the fire to the lumber yard property when a series of explosions involving the cylinders of bottled gas forced firemen to retreat. Lines were again brought into position as soon as the threat of further explosions had diminished. During this brief period of enforced inactivity, however, firemen lost control of flames, which quickly spread to the furniture store building and jumped to and destroyed four other small mercantile structures. Other exposures were now seriously threatened and a hotel a block away was evacuated until the fire was brought under control at 4:00 A.M.

Dawson County Herald.

These stores were exposed to fire in a lumber yard in the Lexington, Neb., business district.

The water supply held out during this fire due to the foresight of the fire chief. Because of the protracted dry spell and the unwillingness of townspeople to save water, Chief Trautman had filled the 93,000 gallon standpipe and then disconnected it from the distribution system earlier in the summer. The standpipe was immediately connected by the water department at the start of the fire and auxiliary pumps were started. There was still a small amount of water in the standpipe at 4:00 A.M. The standpipe water level gradually rose as the number of lines was reduced, and was again full at 10:00 A.M.

Loss to Rosenberg Co.'s building and contents is estimated at $140,000, Rosenberg Lumber Co. $50,000 and Stewart's Pharmacy $82,700 (including business interruption loss of $15,200). Loss of $67,350 was distributed among other damaged properties. Total loss $340,050.

Minot, N. D., Gasoline Fire.

Report by Fire Underwriters Inspection Bureau.

A series of explosions at a bulk gasoline station rocked the center of Minot, killing four persons and causing total destruction or severe damage to four immediately exposed business properties on July 21. Lesser damage was experienced by several buildings within a two-block radius.

Section 45 of the N.F.P.A. Suggested Flammable Liquids Ordinance prohibits the bulk storage of flammable liquids in storage tanks aboveground or outside buildings in mercantile and other congested districts and on land near streams or other waterways that would carry burning liquids into congested districts. (Existing tanks within such limits, properly safeguarded and not presenting a hazard to other property may be permitted.) The wisdom of the provisions of this section is illustrated by the following report of the explosion and fire that destroyed a congested section of the city of Minot.

The initial explosion occurred on the premises of the Westland Oil Co. (see accompanying diagram) consisting of a fire-resistive pump house, a retail filling station and ten horizontal elevated petroleum products storage tanks. The explosion is believed to have occurred beneath or near a 15,000-gal. tank filled with ethyl

Press Association.

Aerial view of group fire at Minot, N. D., July 21. Four persons died and several business properties were destroyed when explosions and fire followed overflow of a 15,000-gallon gasoline storage tank in the center of the city.

gasoline. The building of the Bridgeman Creamery Co., a two-story, part fire-resistive, part brick, wood-joisted structure, was adjacent to the Westland Oil Co., on the south. The Mandan Creamery Co.'s large one-story brick, wood-joisted building was across a narrow street bounding the bulk plant on the north. The Becwar-Cedarstrom Co., consisting of ten above ground oil storage tanks and a one-story metalclad oil storage warehouse, abutted the Westland Oil Co. on the west. The compact warehouse and elevator group of the Minot Farmers Cooperative Grain Assn. was just west of the Mandan Creamery. These four properties were all concentrated within 150 feet of the ethyl gasoline storage tank. No dikes were provided for tanks in the area and none of the buildings was sprinklered.

The storage tank involved in the first explosion had been filled with ethyl gasoline early that morning. Transfer from the tank car had been completed and the pump shut down for a considerable time prior to the explosion. A few minutes before 11:45 A.M., a passerby observed a reddish pink fluid coming from the top of this tank. Before the authorities could be notified, an explosion occurred that shook the neighborhood and alerted the fire department eight blocks away. As soon as a street box alarm gave the location, firemen were on the way. On arrival they found fire at and around the tanks of the Westland Oil Co. and immediately did all in their power to bring the flames under control. The total equipment available to the inadequately manned department was two 1000 g.p.m. pumpers, a hose truck and ladder truck. With the equipment and personnel at hand, the Minot firemen performed commendable service throughout the fire and by judicious use of their hose streams saved several exposed buildings. A major factor in their favor was the comparative absence of wind which at no time during the height of the fire exceeded 12 m.p.h., exceptionally low for Minot.

Cause of the first explosion has not been definitely settled, although explosion within the tank has been ruled out, since the tank was full. A more logical theory contends that the contents of the tank heated and expanded as the day progressed and finally overflowed. Source of ignition is not known. A gasoline-driven electric welding unit 70 feet away and down grade was in operation at the time and was, quite possibly, the igniting agent. The source of ignition is relatively unimportant in this explosion as it was almost inevitable that the escaping fumes would ignite.

Firemen were gaining the upper hand when a second explosion of much greater intensity killed four persons (one a fireman) and ignited several neighboring buildings and spread flames beyond control. Evidence indicates that the second explosion occurred within the tank which had drained itself through connections loosened by the first blast. Air replaced the escaping liquid, forming a combustible gas-air mixture that exploded from the heat of the fire.

The second explosion blew the head from one end of the tank, tossed the tank against two others, which in turn knocked a tank car off the adjacent spur track, and against the Bridgeman Creamery. A hole was blown in the wall of the Mandan Creamery through which flaming gasoline entered the building. This structure was soon a mass of flames. Several other tanks by this time were releasing their flammable contents and flaming liquid seemed to be everywhere, much of it entering storm sewers and flowing to the sur-

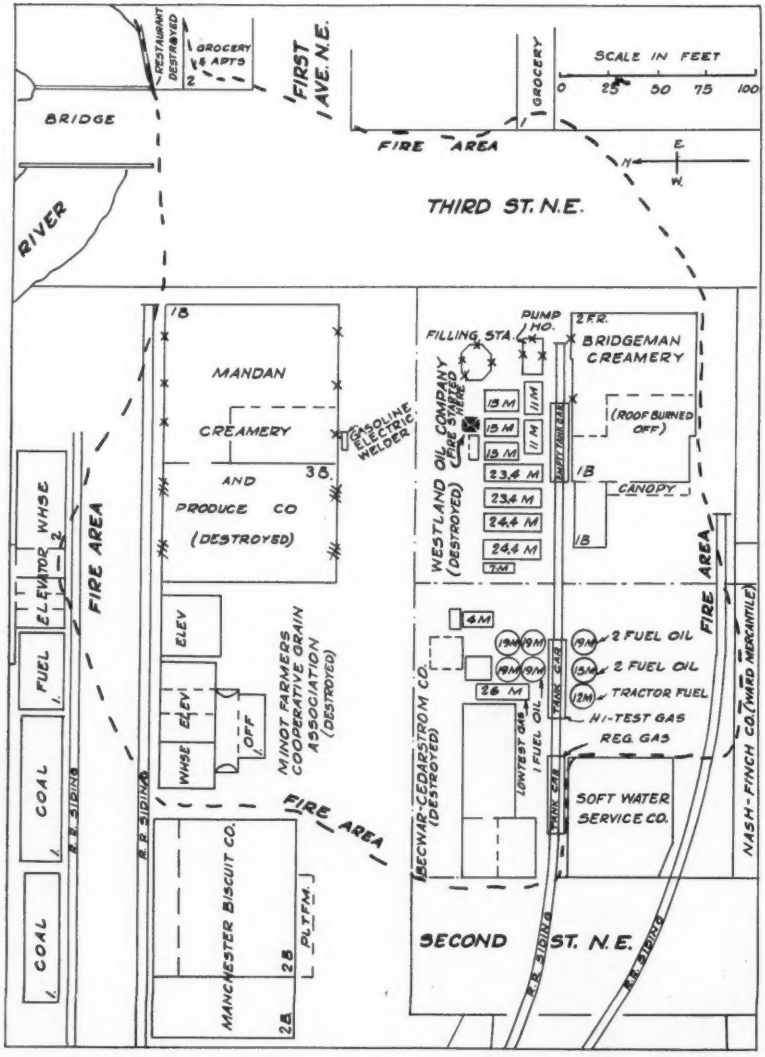

Diagram of bulk gasoline station fire at Minot, N. D., July 21, showing the extent of damage to congested exposed properties. "M" on tanks refers to capacity in thousands of gallons.

face of the river that ran through town. Vegetation on both sides of the stream for several blocks was destroyed and a restaurant on one bank leveled. Repeated explosions and intense heat had forced firemen to retreat and prevented their approach within effective fire fighting distance of the Minot Farmers elevators, ignited by the raging fire in the adjacent Mandan Creamery. They were able to save the Manchester Biscuit Company building, the next in line for destruction, and damage in that two-story metalclad structure was minor.

All manpower and equipment that could be spared battled flames on the roof of the one-story brick, wood-joisted section of Bridgeman's Creamery, which ignited early in the fire. The roof of this section was burned off and the contents destroyed. The adjoining two-story fire-resistive section escaped fire damage, although smoke and water entered the upper floor. This section of the building was in operation the following day. All storage tanks and the metalclad warehouse of the Becwar-Cedarstrom Co. were destroyed. That the recently constructed building of the Soft Water Service Co., seriously exposed, suffered insignificant damage is a credit to Minot firemen, who exhibited excellent foresight in plugging all drains on the parapeted flat roof and flooding the roof with water. The roof was the only vulnerable area in the one-story, hollow-concrete block building.

The total loss resulting from these explosions and fires will exceed $600,000. As a result of this fire, city officials are questioning the advisability of permitting hazardous occupancies to exist in the heart of built-up business districts. The Westland Oil Co. intends to rebuild in a less congested section of the city.

Muhlenberg College Fire.

Failure to call the fire department immediately following discovery of fire was a principal reason, according to Fire Chief Clarence Marcks, that fire inflicted extensive damage on the Administration Building at Muhlenberg College, Allentown, Pa., on May 30. Several deficiencies in building construction and in private and public protection also played a prominent part in the loss.

The 43-year-old three-story, stone, timber-joisted Administration Building housed college offices, classrooms for foreign language, religious and social studies departments, and athletic offices in the basement. It had recently undergone extensive renovation, but unfortunately these alterations did not include installation of automatic sprinkler or fire detection equipment, or enclosure of the building's many horizontal and vertical openings. A bell and clock tower in the center of the large rectangular building extended a story above the gabled and pitched slate roof. First aid equipment consisted of a standpipe with hose in the tower and several fire extinguishers throughout the building. A 4-inch yard main connected to an 8-inch city main supplied water for fire fighting. The pressure was low, however, because of the high elevation of the campus, one of the highest spots in the city.

Shortly before 10:30 P.M., the college watchman on his tour from building to building noticed fire coming from the bell

This report is based on data furnished by the Allentown Fire Department.—Ed.

Press Association.

A 40-minutes' delay in sending an alarm following discovery of fire in the bell tower was an important contributing factor in the destruction of the Administration Building at Muhlenberg College, May 30.

tower. At about the same time the college treasurer, at work in his first floor office, smelled smoke and went outside to investigate. (His assertion that he immediately returned and called the fire department appears to be refuted by records at fire headquarters, which indicate that the first alarm was received some forty minutes later.) Several student and faculty members attracted to the scene by the flames assumed the unfamiliar role of firemen and accompanied the watchman to the third floor, where with extinguishers and a standpipe hose stream they attempted to put out the fire. Their efforts were of little avail and the flames gradually spread out of control and entered the large undivided attic through unprotected openings. At 11:10 P.M., an appeal for help was telephoned to the public fire department.

Two companies responded on the first alarm. Subsequent alarms brought all available apparatus to their aid. In all, nine engines, four trucks with booster tanks and hose, and two ladder trucks responded. First-in companies connected to yard hydrants but found that due to low water pressure and small mains their streams would not reach the roof top. They were forced to relocate at hydrants on 8-inch and 12-inch mains 350 to 1500 feet distant. Fire was now raging out of control beneath the entire roof extending over both wings of the structure and had penetrated to the third floor via stairwells

and through the walls. The fire-weakened roof supports eventually gave way and the slate roof collapsed into the third story, which under the added load dropped to the second floor. Although flames did not penetrate below this level, the tremendous amount of water poured into the building caused lower floors and ceilings to sag. Loss to the building and contents is estimated at $400,000. Insurance coverage had recently been adjusted to meet increased replacement costs and will be sufficient to cover this loss.

Early in the fire, students removed 150 files of business, academic and alumni records from first floor offices. Records on upper floors were a total loss, including one irreplaceable manuscript which had required twenty-five years to prepare. Much of the material it contained was obtained from European archives destroyed in World War II.

Pendleton, Ore., Flour Mill Fire.

Report by E. A. Taylor,
Deputy Fire Marshal of Oregon.

For several hours on July 21, the city of Pendleton was in imminent danger of destruction when fire broke out in the Western Milling Co.'s premises occupying a city block in the heart of the business district.

Nine buildings of various sizes and construction comprised the milling company group. The three-story brick, wood-joisted mill was the largest and oldest, originally built in 1867 and rebuilt following fire in 1897. Two wooden elevators, still not ready for use although construction was nearly completed, adjoined and communicated with the mill. Three one-story wooden warehouses and two small concrete warehouses completed the group. None of the buildings was sprinklered and all were in such proximity to each other that a fire of serious proportions anywhere on the premises would endanger them all. An apartment block, courthouse, warehouse, lumber yard and two service stations were the more prominent immediate exposures on the four streets surrounding the milling company. Business and residential property extended for a radius of several blocks in all directions.

At 12:30 P.M., a dust explosion of mild intensity occurred on the third floor of the mill building. An employee on the second floor (one of the few on duty during the lunch hour) heard the dull thud and noticed smoke and "strings of fire" coming through several chute spouts from the third floor. Another employee ascending to the third floor on a man lift had difficulty in maintaining his balance in the face of the sudden downward rush of air. Continuing his trip, he found one end of the large undivided third story in flames. Returning at once to the second floor, he sounded the plant alarm and was on the way to the first floor office to telephone the fire department when the sound of the city's fire horn indicated that an alarm had been given. The sheriff in his court house office across the street had seen smoke billowing from the upper part of the mill and telephoned fire headquarters. Flames quickly enveloped the upper floor of the mill and were issuing from windows and the head house on the roof when the city's three pieces of apparatus with five on-duty men arrived.

The Pendleton fire department has eleven permanent and twenty-one call

Acme.

A dust explosion on the third floor of the Western Milling Co.'s mill caused this fire at Pendleton, Ore., July 21.

men. Equipment consists of one 1000 g.p.m. pumper, a 500 g.p.m. pumper and a high pressure truck carrying a 300-gallon water tank. The latter was returned to quarters at once. A pumper at the airport was called in later in the day as a precautionary measure. This was the extent of equipment available to the fire fighters. No mutual aid plan had been devised and the Pendleton department shouldered the load alone except for a private brigade from the Harris Pine Mill with 1000 feet of hose and a small group of citizens who picked up some hose at the fire station and manned a line.

It soon was apparent that the fire could not be controlled by in-fighting and firemen retreated to the four boundary streets and concentrated on confining the fire to the milling company property.

Their task was not easy. Flames burst through the roof of the mill in an incredibly short time and leaped to the tops of the adjoining newly built elevators. Simultaneously, fire worked rapidly down through the many vertical openings in the dust-laden mill and swept into the elevators at ground level. Since the explosion and fire occurred during the lunch hour, none of the twenty carpenters normally at work in the elevator were on the job. They would surely have been trapped, as the fast spreading flames blocked the only means of escape through the mill. One after the other, all except one of the warehouses ignited from the intense heat and sparks and the whole block was an inferno. One small concrete warehouse used for storage of drums of cyanide and located on a corner of the property escaped.

Coincident with the spread of fire through the mill group other fires broke out on exposed buildings on all four sides and repeatedly diverted the attention of fire fighters from the principal blaze. The roof of the courthouse was the first to ignite and streams from the street and the cupola were used intermittently to

extinguish incipient fires. The roof of the two-story frame apartment house on another side of the mill required constant attention. A water curtain thrown up in front of the lumber yard saved that property.

For two hours, no one would hazard a guess as to the future course of the fire. Slowly thereafter firemen closed in on the mill property on all sides and from 5:30 P.M. on, the number of hose streams was gradually reduced.

Throughout the afternoon, a gentle northwest wind showered sparks on the residential district southeast of the city and constituted a threat potentially as serious as the downtown fire. Scarcely had the high pressure truck returned to quarters when it was summoned to a grass fire in the residential area. Accompanied by the 1000-gallon city street flusher, this crew was kept busy with a roof fire and several grass fires.

Loss to the Western Milling Co. is estimated at $754,000—building and equipment $284,000, stock $270,000 (including 75,000 bushels of wheat and 350 tons of flour), and business interruption $200,000. Damage to exposures will bring the total to $775,000.

Wichita Garage Fire.

Report by Kansas Inspection Bureau.

Wichita Eagle.

Many minutes were wasted as repeated attempts were made to summon help over a telephone put out of order by this fire at Price Auto Service, Wichita, Kan. No one thought to use the fire alarm box on the lamp post in right foreground.

Violations of several fundamental rules of fire safety were revealed by fire that destroyed or damaged sixty cars in the building housing the Price Auto Service Co. and the Price Motor Co. on Aug. 6.

Originally a two-story brick, wood-joisted structure 14,000 sq. ft. in area, the building had grown with the addition of a two and then a one-story section until the second floor was 35,000 sq. ft. in area and the first 42,000 sq. ft. With the exception of a recently installed all metal paint spray booth on the second floor, no attempt had been made to subdivide fire areas. Unprotected openings connected office and salesroom areas on the first

Wichita Eagle.

Sixty autos were destroyed or badly damaged by fire that swept the Price Auto Service garage Aug. 6, Wichita, Kansas. Fire caused by a broken extension light bulb raced over oil-soaked floors.

floor, and the second floor was one large room with the exception of a partitioned-off stock room. A large ramp and open stairway connected the two floors. The second story, reserved for car storage and repair, had a wood floor in the oldest section. This had become thoroughly oil-soaked during its thirty years of use.

About forty mechanics were at work in the car-jammed second story on the morning of the fire. A few minutes before 9:00 A.M., one of them crawled beneath the rear of a car standing on the wood floor section to remove a leaking gasoline tank. The tank had not been emptied before being permitted in the building. An ordinary extension light with a wire guard around the bulb was on the floor by the mechanic's side. Reports vary somewhat as to what happened next. An eyewitness account which deserves credence indicates that the leaking gas tank fell on or near the extension light. The bulb broke and flames flashed up behind the mechanic. He and another employee attempted to use extinguishers on the fire as it raced over the oil-soaked floor, but were prevented by the intense heat from approaching near enough to hit the flames. The downstairs office was then advised by interdepartment telephone of the fire and a mechanic went to the first floor to find the foreman. After running upstairs to satisfy himself that the fire was out of control, the foreman called the company's switchboard operator and told her to notify the fire department. Repeated attempts over different trunks were unsuccessful. The proprietor was standing on the sidewalk at the time and noticed the flash of fire. He too ran in to verify the presence of fire and after looking up the ramp directed

the private switchboard operator to send an alarm. Burned wires is reportedly the reason that attempts to get help through this medium were futile. A customer in a restaurant across the street, seeing smoke, jumped to the public telephone, but failed to reach the operator when, in his excitement, he forgot to deposit a coin. Three fire alarm boxes were within 200 feet of the fire, one directly across the street. No one thought of these, and the alarm was finally given by firemen who saw smoke from their station two blocks away. Estimates of the amount of time wasted before the alarm was given, vary from eight to twenty minutes.

In any case, it was sufficient to allow fire to burst through large roof monitors and from windows one hundred feet from the place of origin before the first apparatus arrived. Several large ceiling fans without automatic shut offs undoubtedly assisted in spreading flames over the oil-soaked floor and through closely packed cars. Ten hose streams were soon in use, but weak water pressure from the over-taxed six-inch main serving this district soon forced firemen to shut down several of these lines and transfer engines to hydrants on a twelve-inch main a block away.

Water was poured into the building from all sides, but to little avail. A section of wall fell to the street twenty minutes after the first alarm, and it was not long before large sections of the fire-weakened second floor collapsed under the weight of water and cars.

Exposures required attention throughout the fire. Plate glass windows were cracked, neon signs were damaged and roofs were ignited on two large garages facing the fire across 70 and 80-foot wide streets. Damage to a new four-story fire-resistive office building across a twenty-foot alley from the burning building was confined to cracked metal-frame, wired-glass windows.

Loss to the building of origin is estimated at $180,000. Contents (including autos) $128,800. Exposure loss is expected to reach $6,200. Total loss $315,000.

Fires and Fire Losses Classified, 1946.

The National Fire Protection Association estimates that during 1946 there were approximately 608,000 fires, causing $580,000,000 damage. These estimates are computed from annual reports submitted by seventeen State Fire Marshals. It is worthy of note that four more states reported their experience for 1946 than for the previous year, perhaps indicating an increasing awareness by state fire authorities of the value of detailed fire loss statistics. It is through continual study of fire loss data that states and other agencies can identify the most serious fire hazards and take steps to protect the lives and property of their citizens.

Tables I to IV are compilations from Fire Marshals' reports for 1946 or the nearest fiscal year. These tabulations of fire loss data of seventeen typical states are intended to indicate fire experience trends in the nation. Table I shows the number of fires by occupancy in fourteen states and Table II the loss by occupancy in thirteen states. Tables III and IV list the number of fires and loss by cause in the selected states.

In general, these tables do not include many fires outside of buildings, such as rubbish, grass, forest fires, damage to airplanes that burn outside of hangars, or damage to ships.

Table I. Number of Fires by Occupancies in Fourteen States — 1946.

Occupancy	Conn.[1]	Illinois	Iowa	Kansas	Kentucky[3]	Louisiana	Massachusetts[2]	Minnesota	Montana	Nebraska	New Hampshire	Ohio	Oregon[3]	Vermont[4]	Total
I. Public Buildings															
Government buildings	5	....	....	....	2	....	12	1	6	1	9	....	11	2	49
Hospitals, institutions	....	21	7	....	2	12*f*	18	4	2	1	3	22	....	3	95
Schools and colleges	12	72	18	13	7	46	16	15	10	7	3	63	27	8	317
Churches	9	59	15	8	5	7	24	12	3	13	2	91	34	1	283
Theatres, including motion pictures	....	34	9	8	1	17	6	8	1	8	2	31	20	1	146
Amusements, halls	17	51	20	....	5	....	59	14	5	....	11	97	....	6	285
II. Dwellings															
Hotels, boarding houses	27	185	40	42*a*	8	65*a*	95	42	41	25	19	230	415	7	1,241
Apartments, rooming houses	125	2,588	175	....	29	....	....	174	43	60	51	1,802	....	5	5,052
Dwellings	1,144	4,687	1,609	1,194	317	2,673	3,963	1,238	331	772	639	9,203	7,162	816	35,748
III. Mercantile															
Offices and multiple mercantiles	25	169	50	....	10	154	52	50	15	14	....	137	....	5	681
Restaurants, taverns	52	403	103	....	18	....	100	55	36	55	29	....	116	4	971
Miscellaneous mercantiles	198	1,302	167	290	44	131	576	257	59	156	81	2,058	615*g*	112	6,046
Warehouses	29	147	91	4	15	34	158	73	17	27	16	275	48*h*	14	948
IV. Manufacturing															
Metalworkers	9	31	6	3	....	9	19	28	5	....	2	....	33	3	148
Woodworkers	3	11	....	2	7	23	23	....	4	....	2	....	....	15	90
Flour mills, elevators	....	66	17	7*b*	1	18	....	27	4	30	....	....	14	....	184
Packing plants	....	20	10	....	1	....	....	4	2	1	....	....	29	....	67
Bakeries	22	32	7	....	1	....	13	10	1	....	3	....	11	....	100
Laundries	9	62	17	17*c*	5	....	12	....	7	7	6*c*	61	31*c*	2	236
Cleaners, tailors	5	52	7	....	6	....	20	26*k*	1	3	....	29	....	....	149
Misc. manufacturing	75	676	116	12	13	222	334	116	1	43	41	1,030	66	20	2,765
V. Miscellaneous															
Barns	170	368	173	177	18	....	206	88	12	139	72	496	319*i*	80	2,318
Outbuildings	....	1,099	318	....	6	....	209	154	23	117	3	593	....	8	2,530
Lumber and coal yards	9	56	4	7	....	13	37	14	2	4	2	52	151*j*	1	352
Railroad, wharf property	1	195	7	18*d*	2	13*d*	19	8	....	14	....	....	....	....	277
Bulk oil storage, refineries	....	19	....	....	....	48	....	10	1	4	....	....	16	....	98
Garages, filling stations	165	1,404	94	30*e*	50	30*e*	367	65	61	143	42	1,533	73	11	4,068
Power plants, pump houses	1	7	13	....	2	....	8	12	14	....	3	....	....	1	61
Creameries and dairies	....	....	13	....	....	....	....	1	....	1	....	....	11	....	26
Miscellaneous structures	106	561	219	25	6	77	63	325	5	1	7	1,224	31	....	2,650
Motor vehicles	191	2,429	594	293	61	390	589	54	....	206	10	4,138	1,105	....	10,060
Fires other than buildings	2	123	54	....	8	140	12	28	....	88	....	....	....	....	455
Hangars and contents	....	....	....	....	....	....	....	....	....	3	2	....	....	....	5
Total	2,411	16,929	3,973	2,150	650	4,122	7,010	2,913	712	1,943	1,060	23,165	10,338	1,125	78,501

[1]Fiscal year ending June 30, 1946.
[2]Does not include Boston fires.
[3]Number of insurance claims, not number of fires.
[4]Does not include fires with damage less than fifty dollars.
a. Includes amusements, halls.
b. Includes warehouses.
c. Includes cleaners, tailors.
d. Includes power plants, pump houses.
e. Includes hangars and contents.
f. Includes government buildings.
g. Includes offices and multiple mercantiles.
h. Includes railroad, wharf property.
i. Includes outbuildings.
j. Includes woodworkers.
k. Includes laundries.

Table II. Fire Losses by Occupancies in Thirteen States — 1946.

Table II. Fire Losses by Occupancies in Thirteen States — 1946.

Occupancy	Conn.[1]	Illinois[2]	Iowa	Kansas	Kentucky[3]	Louisiana	Massachusetts[4]	Minnesota	Nebraska	New Hampshire	Ohio	Oregon[3]	Vermont[5]	Total
I. PUBLIC BUILDINGS														
Government buildings..	$5,898	.....	.....	.....	$24,000	.....	$39,452	$465	$1,400	$23,780	.....	$55,654	$51,232	$201,881
Hospitals, institutions..	.....	$252,034	$1,421	.....	1,975	$56,338*f*	47,477	3,370	700	35,354	$27,012	.....	941	426,622
Schools and colleges....	8,894	359,565	143,591	$103,808	26,175	390,014	179,171	168,272	104,879	9,164	258,682	200,026	25,486	1,977,727
Churches	24,765	160,320	118,161	9,214	16,250	7,337	191,388	26,435	48,155	1,616	567,703	64,379	7,500	1,243,223
Theatres, including motion pictures.....	.....	21,470	59,804	8,371	3,000	48,133	18,311	41,110	4,059	3,361	17,482	7,062	27,086	259,249
Amusements, halls.....	113,196	98,819	108,083	.....	17,278	.....	228,134	20,875	.....	63,988	97,211	.....	6,529	754,113
II. DWELLINGS														
Hotels, boarding houses	31,234	318,263	225,726	25,011*a*	40,831	90,676*a*	235,350	64,375	16,190	8,209	584,624	182,951	979	1,824,419
Apartments, rooming houses	309,594	172,885	113,100	.....	123,085	.....	.....	112,964	46,467	51,772	692,718	.....	5,856	1,628,441
Dwellings	1,449,583	3,164,019	1,197,713	443,271	587,825	1,821,031	4,044,274	1,276,637	703,504	910,264	3,872,799	2,501,953	1,007,925	22,980,798
III. MERCANTILE														
Offices and multiple mercantiles	78,953	417,925	71,563	.....	1,040,550	363,342	355,111	64,745	6,992	.....	96,680	.....	3,236	2,499,097
Restaurants, taverns...	103,772	513,008	110,600	.....	68,213	.....	317,593	150,886	118,947	103,090	.....	145,287	1,392	1,632,788
Miscellaneous mercantiles	432,375	1,520,397	516,292	1,127,724	458,329	381,885	2,047,922	1,179,865	493,821	408,963	3,622,534	1,171,836*h*	393,143	13,755,086
Warehouses	368,169	2,289,921	376,653	136,206	350,897	89,269	492,385	328,693	536,369	75,070	1,558,529	102,932*i*	20,181	6,725,274
IV. MANUFACTURING														
Metalworkers	12,293	313,785	2,500	39,400	.....	45,944	71,074	28,065	.....	177	.....	43,023	31,820	588,081
Woodworkers	5,700	47,877	.....	775	31,800	163,647	32,881	.....	.....	400	.....	.....	63,559	346,639
Flour mills, elevators...	.....	2,076,622	455,323	87,911*b*	35,000	237,970	.....	4,261,924	440,748	.....	.....	93,350	.....	7,688,848
Packing plants	.....	4,863	7,445	.....	45,000	.....	.....	1,024	65,000	.....	.....	243,939	.....	367,271
Bakeries	84,277	7,255	86,972	.....	300	.....	23,098	13,325	.....	70,798	.....	12,528	.....	298,553
Laundries	16,143	40,535	36,943	13,881*c*	131,555	.....	91,581	.....	942	38,823*c*	97,985	11,765*c*	492	480,645
Cleaners, tailors.....	4,852	96,765	2,601	.....	13,700	.....	28,979	76,650*g*	615	.....	19,736	.....	.....	243,898
Misc. manufacturing ...	422,217	3,599,308	939,993	17,453	201,258	2,542,633	3,042,385	1,169,222	466,299	906,266	2,233,335	1,147,497	280,315	16,968,181
V. MISCELLANEOUS														
Barns	433,592	1,405,323	605,587	286,769	34,455	.....	563,206	350,446	201,525	217,276	1,261,301	482,410*j*	68,803	5,910,693
Outbuildings	.....	207,261	452,586	.....	6,200	.....	134,595	135,510	37,651	7,800	158,944	.....	2,785	1,143,332
Lumber and coal yards.	45,375	496,076	27,865	28,394	.....	102,714	53,446	109,177	11,875	6,290	470,575	1,088,688*k*	285	2,440,760
Railroad, wharf property	350	97,652	8,866	12,585*d*	1,465	64,780*d*	36,493	15,050	6,035	.....	.....	.....	.....	243,276
Bulk oil storage, refineries	.....	43,454	.....	.....	.....	59,187	.....	10,690	1,845	.....	.....	10,107	.....	125,283
Garages, filling stations	192,387	423,615	133,822	45,205*e*	44,520	69,933*e*	479,151	194,534	200,667	115,766	650,644	130,563	22,230	2,703,037
Power plants, pump houses	.....	2,565	5,010	.....	20,300	.....	11,508	4,635	.....	665	.....	.....	715	45,398
Creameries and dairies.	.....	.....	93,190	.....	.....	.....	.....	450	60	.....	.....	4,415	.....	97,845
Miscellaneous structures	281,062	257,367	326,108	109,318	11,950	171,318	33,961	398,992	70,000	16,140	1,243,998	92,886	.....	3,013,100
Motor vehicles.....	69,919	191,159	68,823	41,326	44,361	45,287	96,030	17,122	127,959	4,200	342,015	93,260	.....	1,141,461
Fires other than buildings	2,100	1,570	53,639	.....	4,875	351,362	22,846	32,120	26,436	.....	.....	.....	.....	494,948
Hangars and contents..	.....	.....	.....	.....	.....	.....	.....	.....	94,590	11,500	.....	.....	.....	106,090
Total.....	$4,496,700	$18,601,678	$6,349,980	$2,536,622	$3,385,147	$7,102,800	$12,917,802	$10,257,628	$3,833,730	$3,090,732	$17,874,507	$7,886,241	$2,022,490	$100,336,057

[1]Fiscal year ending June 30, 1946.
[2]Does not include Chicago losses.
[3]Insurance losses only.
[4]Does not include Boston losses.
[5]Does not include fires with damages less than fifty dollars.

a. Includes amusements, halls.
b. Includes warehouses.
c. Includes cleaners, tailors.
d. Includes power plants, pump houses.
e. Includes hangars and contents.
f. Includes government buildings.
g. Includes laundries.
h. Includes offices and multiple mercantiles.
i. Includes railroad, wharf property.
j. Includes outbuildings.
k. Includes woodworkers.

Table III. Number of Fires by Causes in Fifteen States — 1946.

Causes	Conn.[1]	Illinois	Iowa	Kansas	Louisiana	Massachusetts[2]	Montana	Nebraska	New Hampshire	Ohio	Oregon[3]	South Dakota	Vermont[4]	West Virginia	Wisconsin	Total
Chimneys, flues—defective or overheated	128	749	288	75	104	460	67	70	183	1,014	746	60	134	33	1,174	5,285
Sparks on roofs	46	810	369	95	36	113	28	152	....	1,851	430	....	11	6	680	4,627
Defective or overheated heating equipment	277	1,319	177	152	376	527	50	158	126	1,876	1,267	63	74	44	1,702	8,188
Rubbish	151	2,099	146	16	80	....	16	111	30	528	74	37	4	8	199	3,499
Combustibles near heaters	2	91	71	6	27	247	2	....	7	261	....	....	....	....	238	952
Open lights, flames, sparks	167	215	20	10	74	489	3	71	48	526	152	76	11	....	936	2,798
Hot ashes, coals	22	257	51	111	39	71	14	25	9	309	494	6	24	....	233	1,665
Smoking and matches	412	3,063	440	280	685	1,699	104	298	125	4,463	2,183	108	144	50	4,177	18,231
Children and matches	85	....	109	....	....	523	27	....	30	1,044	....	31	....	14	393	2,256
Electrical, fixed service, fires due to misuse, or faulty wiring and equipment	229	3,007	459	299	500	656	62	274*c*	93	3,437	930	67	75	89	1,873	12,050
Electrical power consuming appliances	89	220	187	17	81	323	12	....	14	612	290*d*	23	10	4	1,170	3,052
Flammable liquids, misc. including home dry cleaning and starting fires with	31	1,141	216	128	322	297	29	124	26	1,150	414	30	132	20	294	4,354
Torches, welding, cutting, plumbers, etc.	30	....	55	....	....	97	14	40	6	299	....	13	....	10	84	648
Lamps, lanterns, and oil stoves	95	....	220	....	....	521	27	8	34	....	....	101	....	6	804	1,816
Gas and appliances	....	112	10	25	77	18	16	....	....	261	....	1	3	22	187	732
Grease, tar, etc.	21	225	47	28	49	136	24	....	11	227	526	....	11	4	493	1,802
Spontaneous ignition	49	431	89	32	45	305	20	93	34	560	109	20	9	5	327	2,128
Lightning	18	208	119	37	152	73	12	57	24	209	33	10	45	4	4,367	5,368
Thawing pipes	8	....	6	....	....	24	2	....	4	....	....	....	....	1	10	55
Sparks from machinery, friction	....	44	11	1	56	14	1	....	3	....	292	....	10	1	40	473
Incendiary, suspicious	14	49	36	7	17	123	2	11	3	222	20	4	1	16	90	615
Miscellaneous	164	873	89	158	51	24	....	2	3	2,232	23	4	32	17	34	3,706
Unknown	313	1,322	481	517	990	236	142	167	184	1,499	1,800	92	304	198	990	9,235
Explosions	27	169	75	44	36	34	....	86	17	....	162*e*	37	8	24	602	1,321
Exposure	33	525	202	272	325	177*b*	38	196	46	585	393	15	83	28	334	3,075
Total	2,411	16,929	3,973	2,310*a*	4,122	7,010	712	1,943	1,060	23,165	10,338	798	1,125	604	21,431	97,931

[1]Fiscal year ends June 30, 1946.
[2]Does not include Boston fires.
[3]Number of insurance claims, not number of fires.
[4]Does not include fires with damage less than fifty dollars.
a. Duplicate 160 fires—total number 2,150.
b. Exposures not included in grand total.
c. Includes electrical power consuming appliances.
d. Includes other hot metals.
e. Includes open lights, flames, sparks.

Table IV. Fire Losses by Causes in Thirteen States — 1946.

Table IV. Fire Losses by Causes in Thirteen States — 1946.

Causes	Conn.[1]	Illinois[2]	Iowa	Kansas	Louisiana	Massachusetts[3]	Nebraska	Ohio	Oregon[4]	South Dakota	Vermont[3]	West Virginia	Wisconsin	Total
Chimneys, flues—defective or overheated....	$123,461	$358,225	$221,045	$53,747	$48,737	$596,106	$90,600	$556,459	$322,472	$62,041	$112,189	$59,268	$510,182	$3,114,532
Sparks on roof.....	64,185	265,741	193,068	45,262	53,244	751,616	109,700	672,543	343,631	.....	6,420	8,450	328,543	2,165,948
Defective or overheated heating equipment....	288,672	738,852	216,366	125,965	278,199	1,262,498	168,021	1,629,189	539,517	83,242	66,940	68,390	968,131	6,433,982
Rubbish	150,764	124,704	64,717	4,588	14,733	.....	34,968	171,047	35,227	10,648	592	5,775	80,721	698,484
Combustibles near heaters	1,400	221,757	13,283	361	29,849	325,015	.....	90,346	.....	.....	.....	.....	14,385	696,396
Open lights, flames, sparks	131,616	179,376	17,792	649	62,632	427,727	17,980	400,686	42,244	30,566	2,169	.....	500,936	1,814,373
Hot ashes, coals.....	11,657	143,575	30,790	43,684	29,878	92,058	12,972	163,834	113,868	704	3,978	.....	56,394	703,392
Smoking and matches..	979,188	460,258	331,211	58,134	375,196	2,399,322	167,974	1,440,934	303,325	31,514	102,415	45,941	1,132,479	7,827,891
Children and matches...	87,462	.....	38,744	.....	.....	435,239	.....	342,309	.....	10,013	.....	17,170	89,579	1,020,516
Electrical, fixed service, fires due to misuse, or faulty wiring and equipment	480,164	1,218,317	735,981	218,242	244,073	2,152,056	339,532*a*	1,368,489	688,716	53,029	143,036	326,207	1,412,648	9,380,490
Electrical power consuming appliances....	129,284	334,886	56,680	4,170	100,282	59,232	.....	151,648	50,413*b*	115,631	2,060	1,235	429,433	1,434,954
Flammable liquids, misc. including home dry cleaning and starting fires with.....	33,413	979,413	154,324	55,443	386,018	304,740	155,766	604,708	137,393	18,200	285,918	44,425	269,621	3,429,382
Torches, welding, cutting, plumbers, etc....	23,165	.....	119,088	.....	.....	103,924	73,751	439,438	.....	19,334	.....	9,813	85,626	874,139
Lamps, lanterns, and oil stoves	114,262	.....	123,987	.....	.....	631,505	8,084	.....	.....	53,198	.....	8,640	356,349	1,296,025
Gas and appliances.....	.....	66,010	26,941	20,816	73,755	62,828	.....	328,378	.....	600	1,368	48,193	56,872	685,761
Grease, tar, etc.	14,944	75,439	28,658	15,416	19,791	172,241	.....	324,628	105,191	.....	1,545	874	59,058	817,785
Spontaneous ignition....	126,829	629,638	168,555	26,880	277,515	803,680	556,801	1,262,929	210,343	46,740	21,629	35,522	716,060	4,883,121
Lightning	18,019	446,823	413,322	80,346	217,017	237,499	84,105	261,625	25,404	100,266	33,854	163,575	1,100,302	3,182,157
Thawing pipes.....	10,291	.....	520	.....	.....	18,711	.....	.....	.....	.....	.....	2,200	22,358	54,080
Sparks from machinery, friction	.....	145,520	3,522	300	124,559	46,635	.....	.....	131,178	.....	141,978	5,000	300,038	898,730
Incendiary, suspicious..	9,167	35,171	222,439	127,650	81,559	255,817	100,253	284,793	58,651	8,825	600	92,325	548,237	1,825,487
Miscellaneous	515,538	305,357	386,594	89,470	66,786	30,688	2,165	1,454,416	11,506	2,633	47,147	13,977	9,923	2,936,200
Unknown	1,076,576	9,398,123	2,410,151	1,394,581	4,056,508	2,284,024	1,258,188	5,513,449	4,135,024	166,725	918,162	2,277,132	2,061,519	36,950,162
Explosions	28,577	1,571,209	12,162	70,083	120,300	141,096	139,355	.....	121,891*c*	170,011	9,244	34,000	437,154	2,855,082
Exposure	78,065	903,284	360,040	100,835	442,169	.....	513,515	412,659	510,247	28,416	121,246	119,035	553,769	4,143,280
Total.....	$4,496,699	$18,601,678	$6,349,980	$2,536,622	$7,102,800	$12,917,802	$3,833,730	$17,874,507	$7,886,241	$1,012,336	$2,022,490	$3,387,147	$12,100,317	$100,122,349

[1]Fiscal year ends June 30, 1946.
[2]Does not include Chicago losses.
[3]Does not include Boston losses.
[4]Includes insurance loss.
[5]Does not include fires with damages less than fifty dollars.
a. Includes electrical power consuming appliances.
b. Includes other hot metals.
c. Includes open lights, flames, sparks.

Table V. Fires per 1000 Population and Fire Loss per Person for Thirteen States, 1946, as Reported by Fire Marshals.

State	Population 1940 Census	No. of Fires	Fires per 1000 Pop.	Fire Loss	Fire Loss Per Person
Connecticut	1,709,242	2,411	1.410	$4,496,700[1]	$2.63
Illinois	7,897,241	16,929	2.145	18,601,678[2]	4.13[2]
Iowa	2,538,268	3,973	1.565	6,349,980	2.50
Kansas	1,801,028	2,310	1.282	2,536,622	1.41
Kentucky	2,845,627	650	.229	3,385,147	1.19
Louisiana	2,363,880	4,122	1.742	7,102,800	3.01
Massachusetts	4,316,721	7,010[3]	1.975[3]	12,917,802[3]	3.64[3]
Minnesota	2,792,300	2,913	1.043	10,257,628	3.68
Montana	559,456	712	1.272	4,643,234	8.30
Nebraska	1,315,834	1,943	1.478	3,833,730	2.92
New Hampshire	491,524	1,060	2.159	3,090,732	6.29
Ohio	6,907,612	23,165	3.350	17,874,507	2.58
Oregon	1,089,684	10,338[4]	9.500[4]	7,886,241[4]	7.24[4]
South Dakota	642,961	798	1.242	1,012,336	1.57
Vermont	359,231	1,125[5]	3.135	2,022,490[5]	5.63[5]
West Virginia	1,901,974	604	.318	3,387,147	1.78
Wisconsin	3,137,587	21,431	6.850	12,100,317	3.86
Total	42,670,170	101,494	2.38	$121,499,091	$3.16
Estimated U. S. Total	131,669,275	608,000	4.62	580,000,000	4.41

[1]Fiscal Year Ending June 30, 1946.
[2]Chicago Losses or Population not included.
[3]Boston Fires, Losses or Population not included.
[4]Includes Total Insurance Claims.
[5]Does not include Fires with Damages Less than Fifty Dollars.

States Reporting Partial Data (Not Included in Tabulations.)

	Population	No. of Fires	Fire Loss	Fire Loss Per Person
Colorado	1,123,296	.....	$5,058,534[2]	$4.50
Delaware	266,505	.....	1,809,437[2]	6.75
Maine	847,226	.....	3,339,514[2]	3.94
Michigan	5,256,106	47,698	21,999,225	4.18
New Jersey	4,160,165	.....	13,326,637[2]	3.20
Rhode Island[1]	713,346	1,816	1,973,329	2.76
South Carolina	1,899,804	.....	2,744,765[2]	1.45
Tennessee	2,915,841	.....	6,607,351[2]	2.27
Texas	6,414,824	.....	16,814,432[2]	2.63
Virginia	2,677,773	.....	6,246,999[2]	2.33
Washington	1,736,191	.....	7,204,482[2]	4.15

[1]Fiscal Year Ending September 30, 1946.
[2]Insured Losses Only.

Tables V to VII are recapitulations and estimates for the entire United States based on the four preceding tables. (Certain percentages are added to cover unreported fires and losses as explained below.) In a few instances, adjustment had to be made to the national estimate to prevent distortion of any one occupancy or cause by one or more unusually serious fires in a given class. An example is the loss of $4,261,924 reported by Minnesota for "Flour mills, elevators." Two Minneapolis elevator fires in December, 1946, accounted for about $4,000,000 of this amount. Taking this fact into account, an adjustment was made when estimating national experience for "Flour mills, elevators."

As will be seen in Table V, the seventeen states with a population of 42,670,-

170 reported a total of 101,494 fires. Experience indicates that this is somewhat under half the actual number of fires. Many states, for example, do not report fires with losses of less than $25 or $50. Information from other sources indicates that if all automobile fires were reported the total number would be about 200,000 (instead of the estimated 75,000). The Forest Service of the U. S. Department of Agriculture estimates that 172,278 forest fires occurred in 1946, causing loss of $32,694,113. Fire Marshals do not customarily include forest or brush fire data in their reports. To obtain a more nearly accurate estimate of the number of fires

Table VI. Estimated Distribution of U. S. Fire Losses by Occupancies, 1946.

These estimated figures are intended to show the relative order of magnitude of fire losses by occupancies, and while they are reasonable approximations based on the experience in typical states they should not be taken as exact records for each class.

Occupancy	No. of Fires	Loss
I. PUBLIC BUILDINGS		
Government buildings	1,000	$2,500,000
Hospitals, institutions	800	2,500,000
Schools and colleges	2,300	11,000,000
Churches	2,000	7,000,000
Theatres, including motion pictures	1,100	2,000,000
Amusements, halls	2,500	5,400,000
II. DWELLINGS		
Hotels, boarding houses	9,100	10,300,000
Apartments, rooming houses	48,500	12,700,000
Dwellings	260,000	129,500,000
III. MERCANTILE		
Offices and multiple mercantiles	5,500	14,800,000
Restaurants, taverns	10,200	14,000,000
Miscellaneous mercantiles	43,500	77,500,000
Warehouses	7,000	40,000,000
IV. MANUFACTURING		
Metal workers	1,500	5,100,000
Woodworkers	2,000	3,700,000
Flour mills, elevators	2,400	26,000,000
Packing plants	900	4,600,000
Bakeries	1,100	2,800,000
Laundries	2,000	3,200,000
Cleaners, tailors	1,300	1,700,000
Miscellaneous manufacturing	20,500	60,000,000
V. MISCELLANEOUS		
Barns	17,500	31,000,000
Outbuildings	23,000	8,200,000
Lumber and coal yards	2,800	15,100,000
Piers, including shipyards	2,700	7,500,000
Railroad property	5,400	10,900,000
Bulk oil storage, refineries	1,600	15,000,000
Garages, filling stations	29,500	15,200,000
Power plants, pump houses	700	500,000
Creameries and dairies	900	2,200,000
Miscellaneous structures	18,000	17,100,000
Motor vehicles	75,000	6,500,000
Fires other than buildings	5,000	4,200,000
Hangars and contents	700	10,300,000
Total	608,000	$580,000,000

NOTE: As explained in the text, 100 per cent has been added in estimating the number of fires, and 33⅓ per cent has been added to the losses to cover unreported losses.

Railroad losses have been separated from pier, wharf property fire losses reported by State Fire Marshals. Railroad losses from Association of American Railroads report.

in these seventeen states, therefore, 100 per cent is added. Making use of this figure and the population ratio, the number of fires for the nation is calculated. The estimated number of fires chiefly involving structures for 1946 is 608,000, as compared with 585,000 in 1945, or 4.62 per thousand, as compared with 4.44 in 1945.

To obtain the estimated national fire loss the population ratio was applied to the loss of the reporting states. To account for losses not reported through the usual channels, 33⅓ per cent was added as in previous years. The 1946 estimated loss is $580,000,000, as compared with $485,000,000 in 1945. It is felt that the marked inflationary trend of the last year has been a major factor in this 19.5 per cent increase.

Table VII. Estimated Distribution of U. S. Fire Losses by Causes, 1946.

These estimated figures are intended to show the relative order of magnitude of fire losses by causes, and while they are reasonable approximations based on the experience in typical states they should not be taken as exact records for each class.

	No. of Fires	Loss
Chimneys, flues—defective or overheated	31,000	$17,200,000
Sparks on roof	29,000	12,200,000
Defective or overheated heating equipment	47,500	35,600,000
Rubbish	22,500	4,300,000
Combustibles near heaters	6,500	4,600,000
Open lights, flames, sparks	17,000	10,600,000
Hot ashes, coals	10,000	4,000,000
Smoking and matches	106,000	43,300,000
Children and matches	22,500	8,900,000
Electrical, fixed services, fires due to misuse, or faulty wiring and equipment	70,000	52,000,000
Electrical power consuming appliances	18,500	8,200,000
Flammable liquids, misc., including home dry cleaning and starting fires with	25,500	19,000,000
Torches, welding, cutting, plumbers, etc.	6,000	7,100,000
Lamps, lanterns, stoves	23,500	15,500,000
Gas and appliances	5,000	4,400,000
Grease, tar, etc.	11,000	4,600,000
Spontaneous ignition	12,500	27,000,000
Lightning	31,000	17,500,000
Thawing pipes	1,000	700,000
Sparks from machinery, friction	3,500	7,400,000
Incendiary, suspicious	3,500	10,000,000
Miscellaneous	22,000	16,000,000
Unknown	55,500	204,000,000
Explosions	9,500	20,200,000
Exposure	18,000	25,700,000
Total	608,000	$580,000,000

NOTE: As explained in the text, 100 per cent has been added in estimating the number of fires, and 33⅓ per cent has been added to the losses to cover unreported losses.

This caused by This

But There's a Way to Prevent It!

Automatic Sprinkler Systems undoubtedly are the greatest single contribution ever made to fire protection. Yet without water even the most efficient sprinkler equipment is helpless in case of fire.

Closed shut-off valves and other conditions affecting the water supply and its distribution account for most of the destructive fires in sprinklered properties. Regardless of the number or frequency of inspections, there is always the possibility that a valve may be closed accidentally or maliciously *between inspections.*

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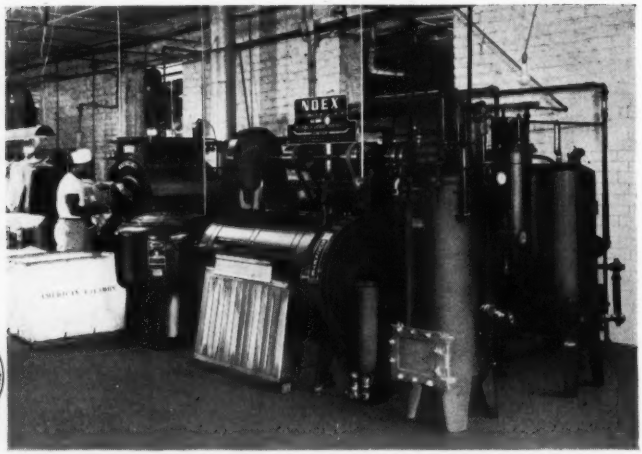

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Replacement type filter units. Dust-Stop 1A and 2A (Dry Type), Class 1. Dust-Stop 1B and 2B, Class 2.

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Fiberglas Mat for use in the construction of Class "A" built-up roof coverings . . . Three layers of Fiberglas Mat . . . Hot coal tar . . . Gravel surfacing applied on hot coal tar.

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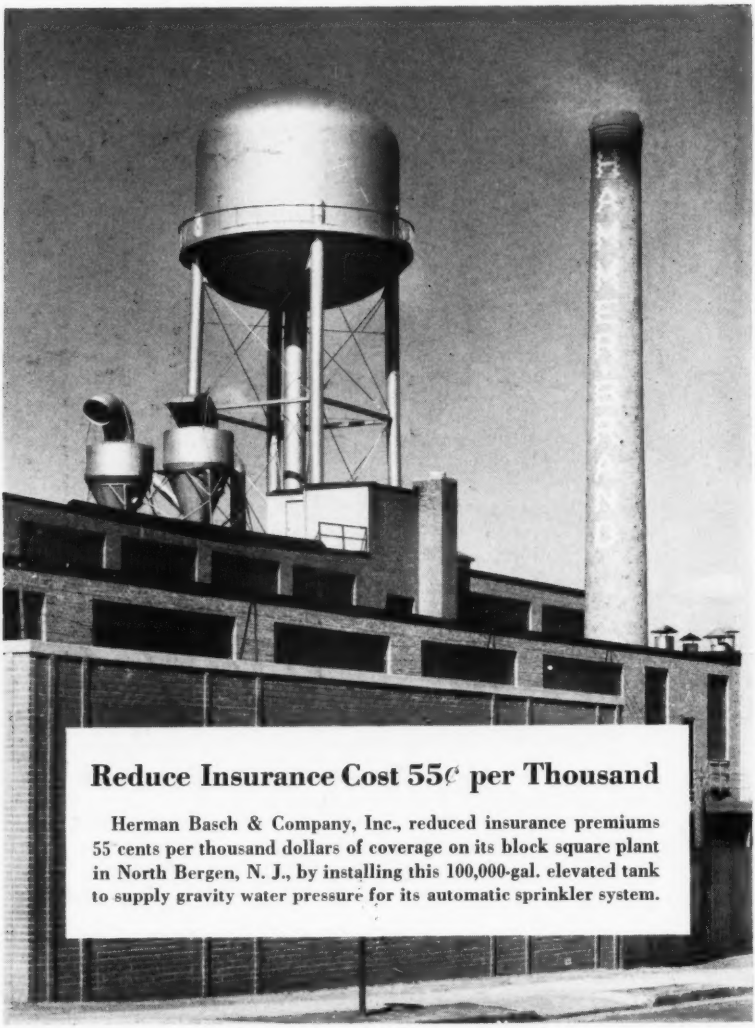
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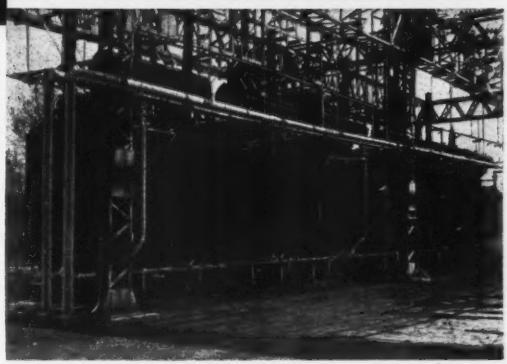

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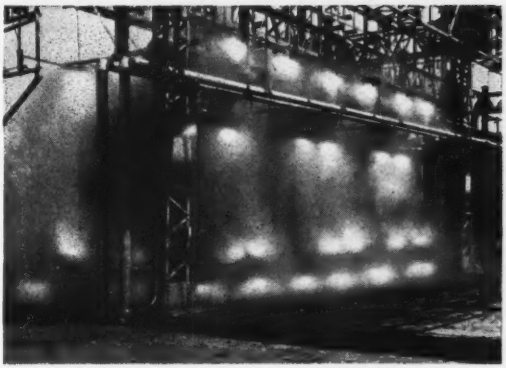

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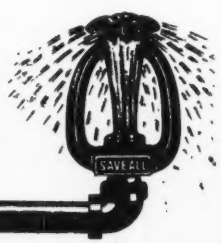

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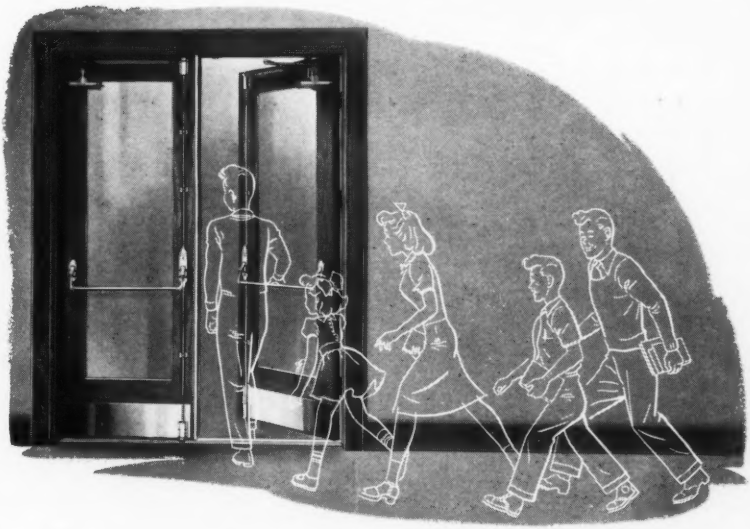

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Von Duprin panic devices provide safe . . . and SURE . . . exit because they are abundantly strong in every part. They stand up under the wear of daily use, and under the terrific demands of emergencies. And they are SURE because the mechanism is so simple, so well balanced that the devices are easily operated, even by small children. Listed by Underwriters' Laboratories, Inc.

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Of

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Star Automatic Sprinklers and Fire Protection Devices bear approval of all Insurance Authorities having jurisdiction and various Governmental Agencies.

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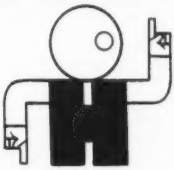

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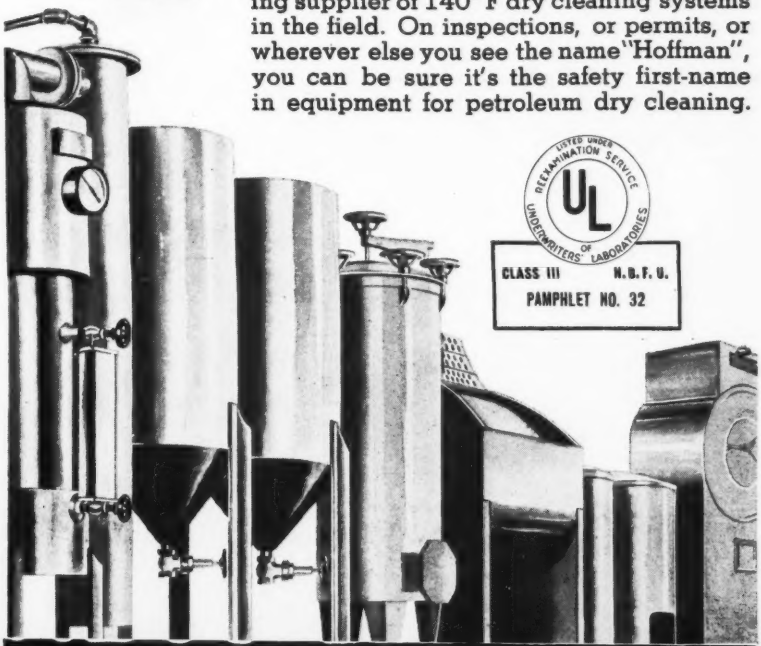

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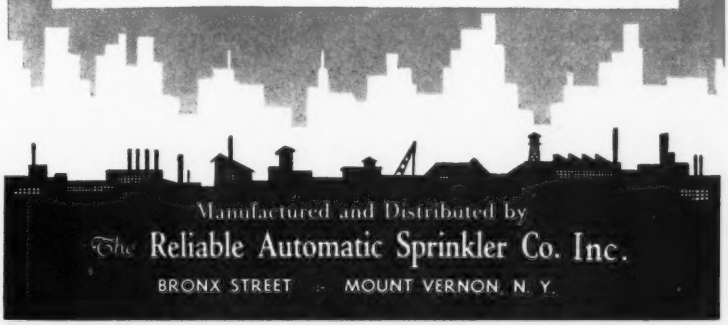

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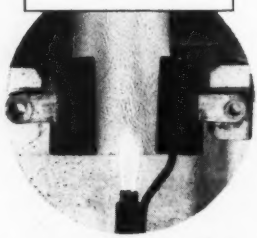

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New York City, Boston and other large cities have certified TOLEX to be FIRE RESISTANT.

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Consulting Service available to you! Without charge or obligation, we will gladly send our technical representative to discuss fire-resistant leathercloth specifications and test methods with fire marshals, fire departments, fire prevention boards or underwriters. Write to . . . Textileather Corporation, Toledo, Ohio.

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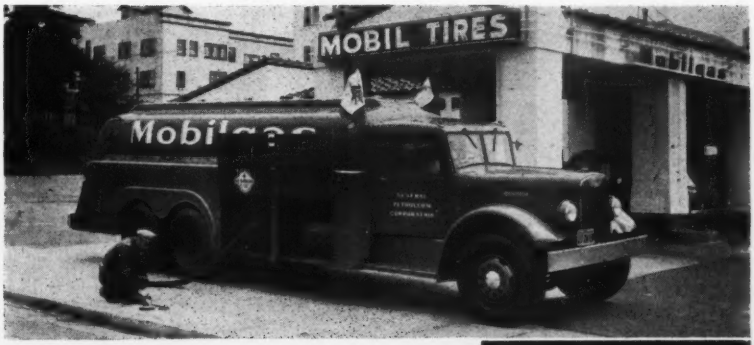

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A petroleum tank truck equipped with S. & J. Internal Hydraulic Safety Valves is a safe truck, both on city streets and highways, and safe when unloading at a filling station. The hydraulic valves located inside each truck tank compartment protect the load in the event of collision or overturning which might break discharge lines. Fusible plugs inserted into the hydraulic line at strategic points release the hydraulic pressure and automatically close the valves in the event of fire during an unloading operation. The system is not new. It has been used by petroleum marketers, large and small, for many years. Would you like to know more about it?

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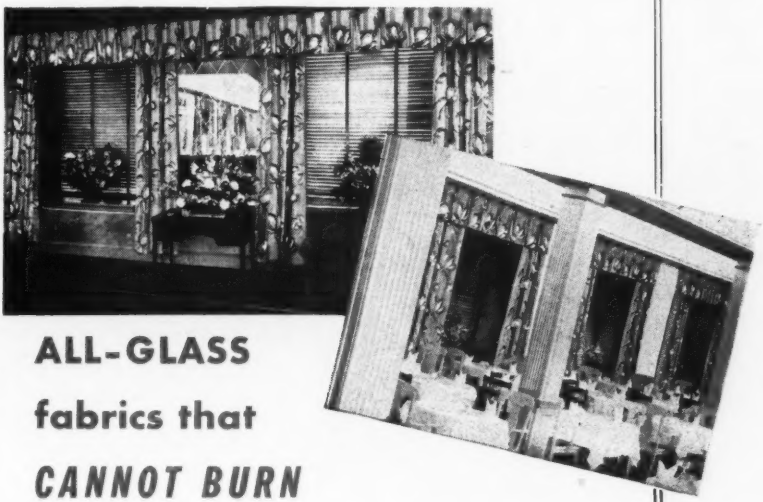

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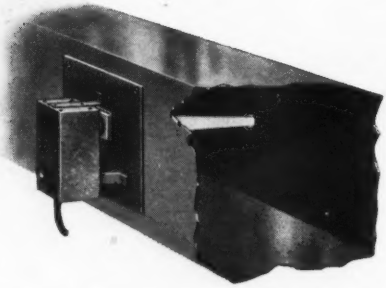
*T. M. Reg. U. S. Pat. Off. Owens-Corning Fiberglas Corp.

VENTILATING FIRE HAZARDS CONTROLLED



By **ELECTRONIC SMOKE DETECTION IN VENTILATING DUCTS**

The Light Source projects a light-beam across the ventilating duct to the Photo-Cell Receiver. When this light beam is intercepted by smoke of predetermined density, the ventilating fan is stopped automatically and warning is sounded! The stopping of the fan, or air flow, permits the natural functioning of ordinary thermally operated fire extinguishing equipment.

THE WORNER FAN MOTOR STOP comprises three units: The Light Source, Photo-Cell Receiver and Control Cabinet. The Control Cabinet contains electrical operating mechanisms, controls, regulators, signals, etc., and may be installed remotely at any point convenient for periodic inspection. Complete installation may be made by an electrician on any ventilating system. It is easy to maintain.

This fire hazard control has been tested by years of successful application and meets the requirements of the National Board of Fire Underwriters. Write for complete details.

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WORNER ELECTRONIC DEVICES

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To sell FIRE PREVENTION
. . *use these Educational Aids*

As a man actively interested in fire prevention you undoubtedly realize the tremendous importance of a community alerted to fire danger . . a community planning and working to prevent fires and minimize destruction once they start.

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"THIS IS GOOD STUFF FOR HOMES, OFFICES AND PLANTS"

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AND PIPE LINE ACCESSORIES

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M & H Tapping Sleeve and Valve (illustrated above) is used to tap a main under pressure for the purpose of taking off a branch leading to automatic sprinklers, fire hydrants, etc. By this method the cut-in is made without interrupting the services on the existing water main.

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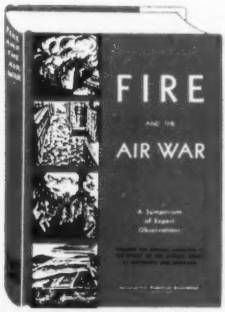
M&H VALVE

AND FITTINGS COMPANY

ANNISTON, ALABAMA

FIRE and the AIR WAR



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"a MUST for public safety officials, city planners, architects, and fire protection engineers."

276 pages
161 illustrations
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The volume is bound in handsome cloth and is printed on a fine grade of high gloss paper to assure faithful reproduction of a large number of photographs, maps, and diagrams.

The destruction of buildings and loss of life due to the air war have raised a host of new problems in the fields of fire protection engineering, architecture, city planning, fire department administration, military intelligence and civilian defense. These relate to the prevention of great loss of life as well as the destruction of buildings.

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LP GAS EQUIPMENT

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PERFORMANCE PLUS SAFETY!

Here's Why:

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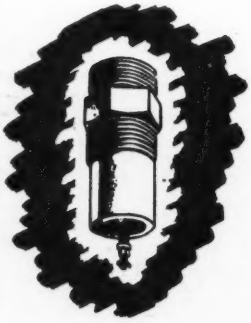

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Hinged types approved by Mill Mutual Fire Prevention Bureau for Class A or Class B installation.

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"Automatic" Sprinkler devices and systems are listed by Underwriters' Laboratories, Inc., and approved by Factory Mutual Laboratories.

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"AUTOMATIC" SPRINKLER CORPORATION OF AMERICA

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